PUBLIC WORKS

Devoted to the interests of the engineers and technical officials of the cities, counties and states

APRIL, 1937

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Contents

EDITORIAL 19

HIGHWAY CONSTRUCTION AND MAINTENANCE:

Cost of Maintaining Low Cost Streets in Elizabeth City. *By James B. Flora* 10
Utilizing Soil Tests for Road Construction 17
Average Costs of Concrete Pavement Construction in New York 18
Contractor's Right to Rescind Highway Contract 18
Locating and Controlling Subsurface Structures 21
Drag Finisher for Concrete Pavement. *By H. D. Johnson* 31
Salt Stabilized Construction. *By Arthur R. Smith* 40
Maintenance Cost Data from Rhode Island 44

SEWERAGE AND SANITATION:

Elutriation Methods and Equipment. *By A. L. Genter* 11
An 8-Community Sewerage Project 16
New York Bill to Regulate Sewage and Water Plant Operators 20
Sewer Construction Under Difficult Conditions 23
A New Pump Control. *By John W. Hood* 37
Workmen's Compensation Premiums on Sewer Department Employees 39
The DIGESTION TANK 45

WATER SUPPLY AND PURIFICATION:

Concentric Cylindrical Filtration Plant of 1.25 M.G.D. Capacity 9
Water Pipe Suspended from River Bridge. *By H. F. Blomquist* 15
Emporia Lays 2½ Miles of Water Main in Two Weeks. *By M. Dunsworth* 20
Typhoid Fever in California from Drilled Well 20
Recovery by City for Pollution of Water Supply by Oil Wells 23
Basic Principles of Taste and Odor Control. *By E. A. Sigworth* 24
Designation of Diesel Engines in Specification Not Illegal 32
The WATER WHEEL 33

DEPARTMENTS:

New Equipment 50
Readers' Service Section 59
The Engineers' Library 62

Index for the year 1936 will be sent to subscribers on request.

TIMEWASTERS

A Bad Egg Situation:

Ikey has 20 eggs; Mikey has 40 eggs; Sambo has 60 eggs; Henry has 80 eggs; Percival has 100 eggs; and George has 120 eggs. At what rate were these eggs sold, so that each received the same price for their eggs and also the same amount of money for them? All eggs were sold. All charged the same rate. All received the same amount of money.

Now this is perfectly possible. What we are particularly interested in is knowing by what mathematical procedure this can be solved. We know the answer, and how to get it, but not mathematically. And the eggs were sold, not given away.

Nuts for the Nutty:

Mrs. Goober, who had four children bought a sack of peanuts. To the eldest, a boy, she gave one peanut, and one-half of what remained; to her second, a girl she gave 1 peanut and one-half of what remained; to her third, a boy, she gave 1 peanut and one-half of what remained; to her fourth, a girl, she gave 1 peanut and one-half of what remained. She' discovered that she had given the two boys 100 more peanuts than the two girls. How many did she keep for herself? From *F. D. Price*, via *McWane C. I. P. Co.*

Some Solutions:

The "8" problem consists of adding 8 plus 8 plus 8 plus 888 plus 88. The match-triangle problem is not an easy one to describe on paper, nor is the one of connecting the nine dots with three straight lines. Answers to these will be sent on request.

Thanksgiving in 2264 will fall on November the 24th, according to Mr. Blunk. Not being much interested in events that far ahead, we have not checked this. Most everyone agrees that the watch problem answer (see January) is 10:15. There is still a good deal of discussion about that flagpole problem. One of the most complete solutions is from Mr. Vinson, who says that it certainly was a time consumer, whether a time waster or not. His report is that the length of the broken-off piece is 50.7875388211 ft. Near enough. The echoes of the footsteps of that fox and the roar of that auto are still reverberating also. That *was* a problem.

Our regards to Mr. Vinson, and apologies for not answering his pleasant letter; also welcome back to the fold for Mr. Reichstein, one of our original sharks. He and several others have been worried about the nines and elevens problem in the March issue. Who can help them out? We pass the buck. W. A. H.

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A. PRESCOTT FOLWELL, Editor — **W. A. HARDENBERGH**, Asso. Editor

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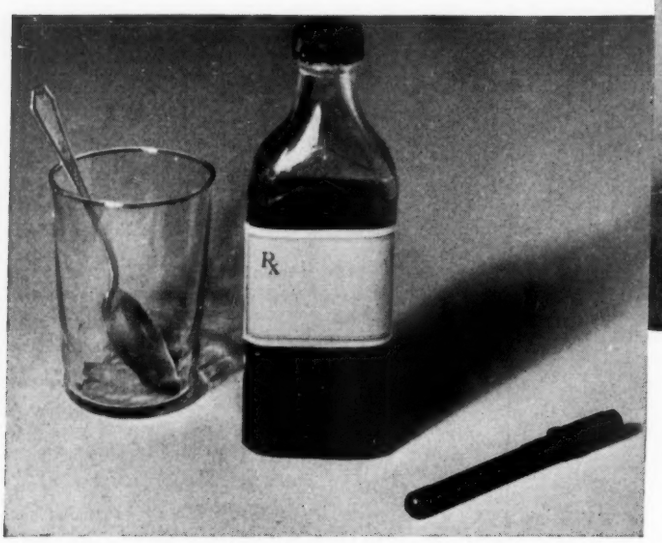
FOUNDED IN 1896

"SPRING — *tra la la*"

"BASEBALL" . . . . . .
"THE OLD SWIMMING HOLE"
"PEN KNIFE" . . . . . .
"HIKES" . . . . . .
"SULPHUR and MOLASSES" etc.

All typical of Spring—the time of the year when poets tell us a young man's fancy turns to love, etc.

But Spring also brings to the Plant Operator its full share of seasonal troubles. April



Showers not only bring forth May Flowers but also increased water flow — spring floods—and a general breaking up of ice, all of these resulting in increased taste and odor problems.

Seasonal road repair work, particularly involving the use of tar products, usually result in phenolic tastes being contributed to the water supply.

(1) May we, therefore, suggest that all plants be fully prepared for increased sterilization required through the application of sufficient chlorine.

(2) That sufficient NUCHAR (Activated Carbon) be fed to adsorb these tastes and odors and therefore result in the furnishing of a palatable water.

The cost is so little that you will enhance your consumer relationship through so doing.

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PUBLIC WORKS

City, County and State Engineering and Construction

Vol. 68 *April, 1937* No. 4

Concentric Cylindrical Purification Plant of 1.25 MGD Capacity

A CIRCULAR purification plant, similar to that built in 1934 at Burnt Mills for the Washington Suburban Sanitary District (see PUBLIC WORKS for August 1934 and May 1935), has been built to purify the water used by the District of Columbia Penal Institutions in Fairfax County, Virginia. The capacity is 1.25 mgd, or one-fourth of that of one of those in the similar Burnt Mills plant.

These institutions, on a reservation of about 2,700 acres, consist of three separate groups of buildings—a work house for men, a reformatory for men, and a women's department. The population served is from 2,800 to 3,000, housed mostly in dormitories. The permanent buildings number 75, including 18 residences for officials and 12 industrial buildings. The water consumption varies from 450,000 gpd in winter to 700,000 gpd in extremely hot weather.

The plant is enclosed in a cylinder of steel plate 50 ft. in diameter, inside of and concentric with which are two other cylindrical steel shells, all with seams electrically welded. The outside annular space, with a capacity of 60,000 gals., serves as a clear-water reservoir. The annular space inside this is used as a coagulating basin, giving a retention period of about 1.1 hrs. The third annular space is divided into four parts, each containing a rapid sand filter. In the center of the structure is the pipe vault, an extension of this above the top of the filters serving as the operating room. Also extending above the tops of the cylindrical walls is an "aer-o-mix" which both aerates the water and mixes the chemicals with it.

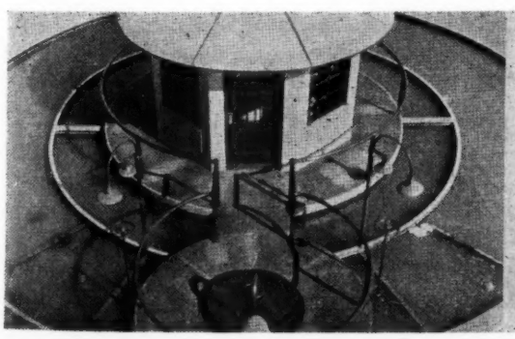
In addition to this cylindrical structure there is a 100,000 gal. clear-water reservoir and a 10,000 gal. elevated tank which provides water for washing the filters.

The filter beds are supported on a grating, leaving a space between them and the bottom of the structure which serves as an underdrain which gives practically no friction loss to the filtered water or to the wash water, thus securing a uniform distribution of the latter.

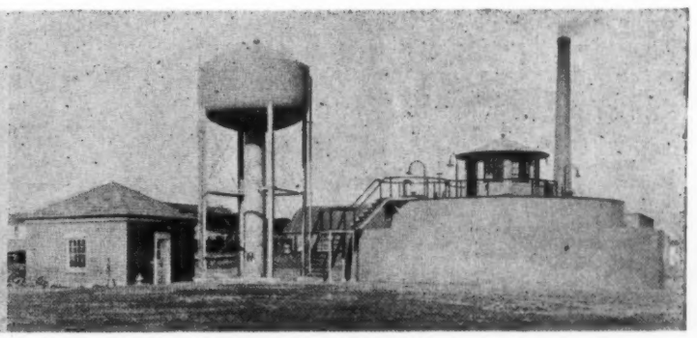
The original supply of the institution was from dug wells for the potable supply and from a creek for non-potable. But the wells became inadequate and the creek water so salty as to cause trouble in steam boilers, and a new supply was obtained from two creeks above tide water contamination.

This water is raised by two electrically driven pumps 220 feet through 4500 ft. of 12″ pipe to a 1,000,000 gal. reservoir, from which it flows 2500 ft. by gravity to the filter plant. Here, lime, alum and activated carbon are applied and mixed with the water for ten minutes, the water then going to the sedimentation basin, and thence to the filters; from the annular clear water reservoir through a 16″ pipe to the additional clear water reservoir; and from this is raised by high-lift pumps to the elevated steel tanks of the distribution system.

The plant was constructed under the direction of Capt. Howard F. Clark, assistant engineer commissioner of the District of Columbia, the direct supervision of the work being in charge of Herbert R. Haar. The steel work was furnished by the Chicago Bridge & Iron Co.



View of filter plant from above. Aer-o-mix in foreground. Control house in center.



General view of purification plant at District of Columbia's penal institutions.

Cost of Maintaining the Low-Cost Streets of Elizabeth City, N. C.

By JEROME B. FLORA, Mayor

THE main streets of Elizabeth City, county seat of Pasquotank County, North Carolina, were paved many years ago, largely with brick, but little had been done on the residential streets. These consisted of the natural soil, which is very sandy, and unfortunately, their surfaces are only from 2½ to 3½ feet above high tide. The tidal water is often brackish, keeping the ground rather moist, and during wet weather traffic on these unsurfaced streets was very unpleasant to say the least.

Dyer St., Elizabeth City, March 4th, 1937.

In 1926 a start was made in improving some 62,000 square yards of unsurfaced streets by spreading and compacting on them five inches of James River gravel. The gravel surface was maintained until the following April, when it was supplemented with a surface treatment.

The original surface treatment consisted of cleaning off the loose material, brooming the dust from the surface, and applying 1/3 gallon of Tarvia B prime per square yard. This was followed by an application of ¼ gallon of Tarvia A (a heavy hot-surface treatment tar) which was covered with ¼" to ¾" limestone chips, about 28 pounds of chips per square yard, and rolled. These chips cost $2.80 a ton f.o.b. Elizabeth City. Twenty thousand gallons of tar prime and 16,000 of surface treatment tar were used. The cost of this tar, applied with a truck pressure distributor, was 16.6 cents per gallon. This work was done with city forces at a cost of 17.04 cents a square yard, distributed as follows:

Cost of 1/3 gallon tar prime, applied	$ .0553
Cost of ¼ gallon tar surface, applied	.0426
Cost of 28 pounds of stone chips on surface	.0705
Cost of heating	.001
Cost of rolling and brooming	.001
Total Cost	$ .1704

Very little rolling was done on this surface treatment, as the roller broke down shortly after work started, so most of the compaction was done by traffic.

The following year these streets were given a seal coat, consisting of 1/3 gallon of Tarvia A per square yard, covered with about 28 pounds of slag chips from ½" to ¼" in size. Eighteen thousand gallons of tar were used for this seal coat surface at a cost of 13.3 cents a square yard.

These streets were given a surface treatment in 1932 and again in 1936, using Tarvia A in each instance. In between these years a small amount of patching was done, largely of surface replacements due to pavements cuts for water connections.

While it is impossible to figure exactly the cost of maintaining these streets in excellent condition, we do know how much was spent for tar each year. The patching binder used was largely Tarvia K.P. purchased in drums, although after each complete resurfacing some surface treatment tar was reserved and stored in drums until needed for patching.

The tar used each year with its cost is shown in the following table:

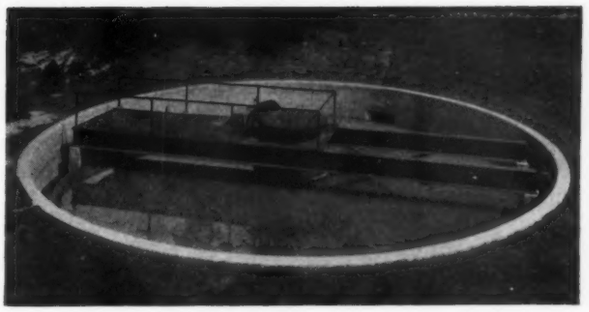
Year	*Gallon Tar*	*Cost*	*Cover Tons*	*Cost*
1929	371 (bbls.)	$ 72.20		
1930	318	58.83		
1931	843	163.24		
	1532	296.27		
1932	530	102.82		
Retreatment	20,303 applied	2,598.78	650 slag	$1,300
1933	529 (bbls.)	101.60		
1934	159	31.80		
1935	477	95.40		
1936	477	95.40		
1936 Retreatm't	24,000 applied	2,797.53	700 slag	1,400

Taking the above figures for material costs and estimating a very liberal aggregate and labor allowance, we feel that Elizabeth City has had very serviceable, smooth riding and good appearing, residential streets with an annual maintenance cost for nine years, including two surface treatments, of less than 3½ cents a square yard a year. Including the cost of the original tar surface treatment and seal, distributed over the eleven year period, the annual cost is about 5½ cents a square yard, with apparently several years of excellent service with only light maintenance, before another surface treatment will be required.

Highway Contractor Not Liable for Condition of Detour

The New Mexico Supreme Court holds, Hendrickson v. Brooks, 53 Pac. (2d.) 646, that a contractor engaged in oil surfacing eleven miles of new highway paralleling the old highway, who had put up the usual "detour" warnings to keep the traffic off the new highway, was under no duty to place warning signs on the old highway which was being maintained by the State highway department with a maintenance crew which passed over the road frequently, and was not liable to a motorist who obeyed the contractor's detour sign and was injured by a dip or drainage ditch cut across the highway at a right angle by the removal of the oil surface and base.

In PUBLIC WORKS *for November, 1934, we published a description of investigations conducted at the Baltimore sewage works by Mr. Genter, and the development thereby of a method of treatment to which the name of "elutriation" was given. Application of the principle has been studied intensively since then and the method has been adopted by several plants and is now recognized as one of the accepted tools of the sewage engineer. In the following article Mr. Genter gives, in the most practical description so far written, all details necessary for understanding, planning, designing and operating an installation. The different methods of elutriating have never before been defined and described in any published article or paper. This article should therefore be of unusual value to all who are interested in sewage treatment.*



Typical elutriation tank 22 ft. in diameter, using Dorrco thickening mechanism. Similar in size and nature to the tanks used at Winnipeg, Greensboro and Patapsco. Baltimore, Los Angeles and other installations will use larger diameters. Washington, D. C., is to use rectangular tanks.

Elutriation Methods and Equipment

By A. L. GENTER
Baltimore, Md.

ELUTRIATION of sewage sludges comprises the removal of soluble decomposition products from the moisture associated with the sludge solids by the use of water that is comparatively free of such compounds.

In its simplest form elutriation involves: 1.—the dilution of the sludge with water, 2.—the rapid and thorough mixing of the sludge and water to form a weaker solution of the dissolved decomposition products present in the sludge moisture, 3.—sedimentation of the sludge solids in the diluted mixture to a new sludge, and 4.—decantation of the weaker solution. The term *elutriation* comprehends these four essential steps relied upon for effecting this specific type of purification. The wash water used is called *eluent* or *elutriating water,* and the weaker solution removed by decantation is termed *elutriate*. The sludge solids collected in the fresher water then go to make up the *elutriated sludge.*

The Purpose of Elutriation is to considerably reduce the amount of coagulating chemical needed to render the sludge solids more readily dewaterable in modern continuous vacuum filters. Normal sludge moisture contains dissolved decomposition compounds sufficient to form objectionable amounts of gelatinous precipitates with chemicals like ferric and aluminum salts and lime. The amount of these precipitates is largely a function of the moisture present in the sludge and of the dissolved decomposition products present in the sludge moisture. These precipitates are not only difficult to drain free of moisture in modern vacuum filters, but their formation unnecessarily consumes chemicals intended for coagulating the sludge solids. These solids are normally gelatinous, colloidal aggregates which can easily be coagulated by small amounts of ferric or aluminum salts when surrounded by relatively pure water. In order to obtain the best filtration results, the numerous gelatinous chemical precipitates resulting from the addition of such chemicals should be absent.

The following economies result from elutriation: a.—the amount of chemical used is reduced by 65 to 80 per cent, b.—the filter cake contains materially less ash. The use of lime can increase the cake weight 25 to 30 per cent, which is detrimental to the economics of final drying and incineration of the cake. Elutriation completely eliminates the use of lime. c.—Greater freedom from the effects of insufficient digestion time and space is secured. d.—Filter dressings last considerably longer, due to the elimination of cloth incrustation which results from the use of lime. e.—The sludge from elutriation has more uniform solid content and more uniform behaviour toward coagulating agents.

These items are of importance in continuous operation of vacuum filters. The savings in chemicals alone resulting from sludge elutriation should retire the cost of installing the process in 18 months in most cases.

Present Installations.—Although sludge elutriation is a novel departure in the preparation of sludges for final disposal, it should be noted that the conclusions relative to its definite economies are not drawn entirely from the exhaustive investigations made at Baltimore, Md. Investigations made elsewhere in the United States, Canada and Germany on various types of digested sludges have produced results quite similar to those obtained in Baltimore. Sludge solids from various domestic sewages behave remarkably alike toward coagulants when the normal sludge moisture is displaced by relatively pure water.

This process was first adopted for the new sewage treatment plant at Washington, D. C. Other installations under construction and definitely projected are at Hartford, Conn., Greensboro, N. C., Winnipeg, Manitoba, San Francisco and Los Angeles, Calif., Baltimore and Patapsco, Md.

Methods of Elutriating.—When elutriation is practiced in mechanically operated settling tanks so that the foregoing steps 1 to 4 are carried out continuously and practically simultaneously, the procedure is termed *continuous elutriation.* Otherwise the process may be *intermittent,* i.e., practiced on separate batches of sludge and water in intermittently charged and drained settling tanks. When a sludge is elutriated but a single time in one settling tank, the process is termed *single-stage elutriation.* If the elutriating water is divided into two or more fractions and the same sludge is suc-

cessively elutriated with each water fraction, the procedure is *fractional elutriation.* If weaker elutriate from a sludge that has been elutriated with fresh water is used for washing a new charge of unelutriated sludge, the process is termed *counter-current elutriation.* Any of these procedures can be intermittently or continuously operated. There can also be a combination of these two operations, namely, *semi-continuous elutriation,* whereby continuous elutriation is practiced during a fraction of each day only.

It can be mathematically and practically demonstrated that fractional elutriation is economically superior to single stage treatment, and counter-current treatment is superior to fractional treatment. For example, by elutriating one volume of sludge in three volumes of water in two continuous sedimentation tanks by the counter-current method, practically as much of the original sludge moisture will be displaced by the pure water as will be accomplished when using two successive fractions of about 3 volumes of fresh water in each fraction, or when using 10 volumes of fresh water in single stage elutriation. In this last case the single treatment tank would have to be larger.

Continuity of elutriation operations offers such obvious advantages that it should be used wherever practicable. The principal advantages are the saving in tank space and the continuous production of sludge having thoroughly uniform characteristics. This is of vital importance in delivering sludge to continuously operated vacuum filters.

Principal Equipment

Modern mechanically operated sedimentation tanks (also known as settling tanks, thickeners, clarifiers and decantation tanks), which are so constructed that they can be operated continuously at very little cost, are ideally suited for the continuity of elutriation operations. Such tanks should be used in all cases, even for intermittent elutriation. All other equipment is accessory to such continuous sedimentation tanks, namely, mixing tanks for continuously diluting and thoroughly mixing the sludge and elutriating water, pumps for continuously mixing the sludge, and meters for maintaining definite ratios between water and sludge.

After mixing the water and sludge and feeding the mixture to continuously operated sedimentation tanks, the suspended sludge solids settle through the water and thereby are thoroughly washed. The proper arrangement of two such sedimentation tanks and mixing troughs in series makes it possible to move both the sludge solids and the greater bulk of elutriating water continuously and simultaneously counter-current to each other, thus securing excellent washing efficiencies in the least tank space.

Elutriation Method Recommended.—In plants serving less than 100,000 population, single-stage elutriation is sufficient for all practical purposes, and will effect material chemical savings in any plant; but the use of two tanks will be found more economical for all larger installations. They can be employed for either fractional or counter-current elutriation. The question of continuous 24-hour operation will be governed by the necessity of the final disposal method employed.

Operation of Counter-Current Installation.—It will be seen from a study of the attached installation diagram that in continuous counter-current elutriation the sludge moves from the digesters through the mixing and sedimentation tanks in one direction while the continuously added and decanted elutriating water moves in the opposite direction.

In the diagram only two sedimentation tanks are shown, as investigations prove that such an arrangement is ample for the elutriation of sewage sludges, especially when using a maximum of about three volumes of elutriating water to one of sludge. Due to the adsorptive properties of the sludge solids, a third tank would result in saving very little extra coagulant.

In the diagram shown, the sludge from digestion flows (or is continuously pumped) into mixing tank 1, where it is mixed with the clarified elutriate that continuously overflows from sedimentation tank 2. In this mixing tank the inflowing elutriate and sludge are quickly but intimately mixed by mechanically operated paddles, baffles, or diffused air. The diluted mixture then flows to sedimentation tank 1, where the solids settle to a sludge. The elutriated sludge from this tank is continuously pumped to the mixing tank 2, into which the fresh elutriating water continuously flows. The mixture produced in mixing tank 2 flows to sedimentation tank 2, where the solids settle to the final sludge which is continuously conducted to the sludge well in the vacuum filter plant. The clarified overflow from this final sedimentation tank is used for elutriation of the inflowing digested sludge as already indicated. The clear overflow from sedimentation tank 1 contains most of the displaced original sludge moisture and is conducted to the plant pre-sedimentation system.

In order to avoid pumping elutriate from one tank to the other and to provide proper flow conditions through mixing tank 2, sedimentation tank 2, mixing tank 1 and the final sedimentation tank 1, the two sedimentation tanks and their mixing troughs are so arranged that gravity flow results. This is accomplished by providing a sufficient difference between the high water levels in tanks 2 and 1, as determined by their overflow weirs or rims. (The average differences in elevations is indicated in the sectional view of the installation diagram.) The two tanks can then be constructed to have a common operating floor level.

Type of Continuous Sedimentation Tank.—Circular tanks with peripheral overflow rims are generally the least expensive to install and are preferable for obtaining the clearest elutriate. If rectangular tanks with endless chain sludge collectors are used, a single tank can, by means of a dividing wall, be made into two separate sedimentation and elutriation compartments. Such an arrangement occupies the least space but is not necessarily the cheaper to install. The tank area required for elutriation purposes is quite small when compared to tank areas used for settling solids.

Although sedimentation tanks in sewage treatment plants are commonly constructed of reinforced concrete, elutriation sedimentation units, on account of their small size, may well be made of other materials, particularly where the entire equipment may be placed in a building. In the Winnipeg installation both sedimentation tanks and mixing tanks are of ¼" steel plate alloyed with material resistant to the action of the dissolved carbon dioxide in the elutriated sludge; all metal surfaces being given two coats of black iron oxide primer, followed by a coat of aluminum paint and finally two coats of a good gilsonite paint. Although the elutriation equipment in the San Francisco installation is likewise being placed in a building, the sedimentation units will be constructed of concrete, of rectangular design.

The elutriation tanks at Washington, D. C., and Hartford, Conn., are rectangular, with end weir overflows and endless chain sludge collecting mechanisms. At Washington one rectangular concrete tank is in-

stalled with four compartments and four sludge collecting mechanisms, so arranged that each two compartments constitute a single treatment stage. At Winnipeg, Baltimore, Patapsco, Greensboro, and Los Angeles, circular tanks will be used.

Scum baffles are of advantage in elutriation tanks that are intended to operate but 7 or 8 hours daily and but 6 days weekly. During the prolonged rest periods in hot weather, the tanks are left full of water and sludge, and some partially digested solids may float to the upper surface of the liquid. Spraying this surface with water will cause the solids to sink rapidly when operations are started again. The baffle keeps the overflow free from entrained solids.

The overflow weirs of the elutriation tanks should be adjustable and the effluent launders should be accessible. The sludge collecting mechanisms should be motor driven; also they should be of a type that will accumulate and move the heaviest sludge that can conveniently be pumped, for the less moisture there is present in the sludge leaving tank 1, the less of this moisture will have to be displaced through elutriation in mixing tank 2 and sedimentation tank 2.

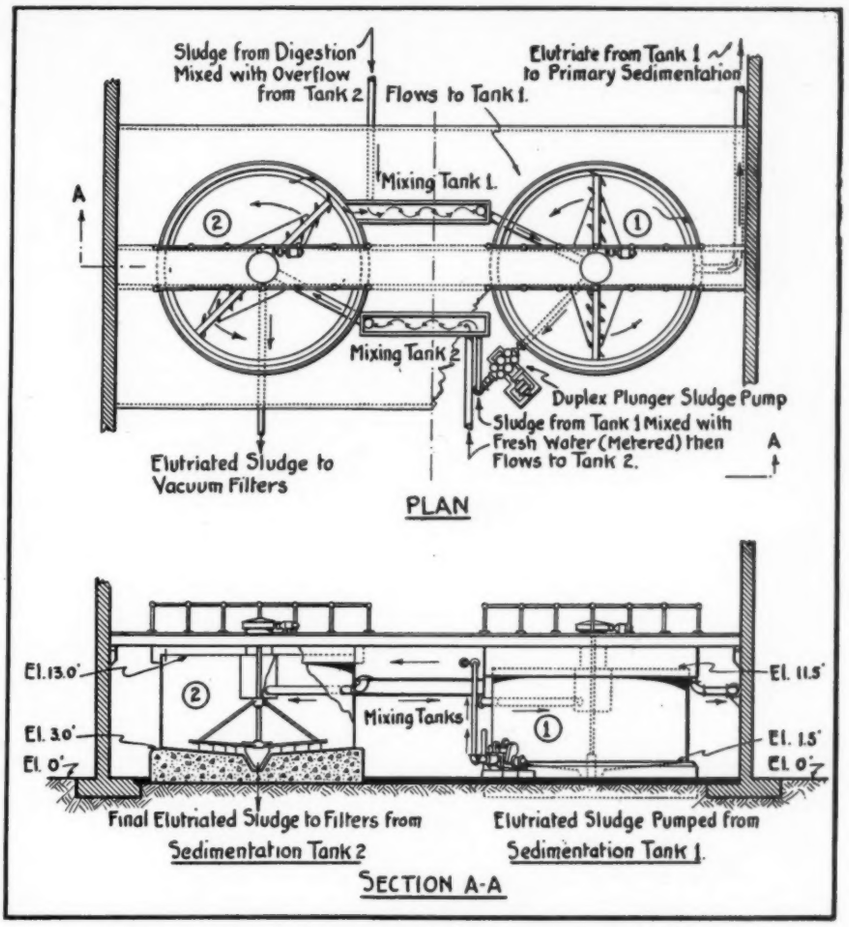

Sludge from Digestion Mixed with Overflow from Tank 2
Flows to Tank 1.
Elutriate from Tank 1 to Primary Sedimentation
Mixing Tank 1.
Mixing Tank 2
Duplex Plunger Sludge Pump
Sludge from Tank 1 Mixed with Fresh Water (Metered) then Flows to Tank 2.
Elutriated Sludge to Vacuum Filters
PLAN
El. 13.0'
El. 3.0'
El. 0'
Mixing Tanks
El. 11.5'
El. 1.5'
El. 0'
Final Elutriated Sludge to Filters from Sedimentation Tank 2
Elutriated Sludge Pumped from Sedimentation Tank 1.
SECTION A-A

Diagram of equipment arrangement for counter-current elutriation.

Accessory Equipment

1. *Mixing Tanks.*—These tanks can be of concrete or steel and should be provided with some simple means for thoroughly but quickly mixing the water and sludge, such as diffused air supplied through Aloxite diffusion tubes or plates, baffles, or mechanically actuated stirrers. Diffusion plates are used at Washington, D. C., baffles at Greensboro, and mechanically oscillated paddles at Winnipeg. The mixing should be sufficient to keep settling solids in suspension but not violent enough to break the natural sludge floc. The sludge influent to the mixing troughs should be visible.

2. *Sludge and Water Meters.*—Although counter-current elutriation permits a rather wide range of water-to-sludge ratios, without materially altering settling rates and washing efficiencies, some method of measuring the sludge and water should be provided. Venturi meters can be installed in the lines carrying the inflowing sludge and water. With recording meters, if one meter be used on the line conveying diluted sludge to tank 2, and another meter on the elutriating water line, the actual sludge handled can be found by difference. Valves can be used for regulating the sludge and water ratios.

3. *Sludge Pumps.*—A motor-driven simplex or duplex plunger pump, according to the size of the installation, with single-acting plunger chambers and accessible ball check valves and wearing parts, should be used for continuously moving the elutriated sludge from the first tank to the mixing tank delivering diluted sludge mixture to the second tank. Such pumps should be equipped with adjustable eccentrics which easily permit varying the pump capacity to 10 times a given minimum.

In order to regulate the flow of the sludge from the digestion tanks to the elutriation plant, a similar pump can be used, in which case both pumps will have the same capacity. The use of such plunger pumps is advisable, as this type has less tendency to disintegrate the natural floc of the sludge particles.

The power requirements for moving the sludge between the sedimentation tanks are negligible, due to the very low operating head.

4. *Piping* of proper size is necessary for connecting the entire elutriation equipment to elutriating water supply, digestion tanks, primary sedimentation and vacuum filters, All right-angle turns in sludge lines should be made with tees, and every sludge line should be equipped with cut-out valves and water flushing connections in case of stoppage. Cross connections between the various units and lines may also be supplied. These are not shown in the attached drawing, but will be discussed under special features.

5. *Walkways* with supporting structures, hand railings, floor gratings and proper illumination equipment are necessary about the entire installation.

Sizes of Tanks

Continuous Sedimentation Tank.—When operating 23 or 24 hours daily and treating sludges by counter-current elutriation with 3 volumes of water for each volume of sludge, there will be required a miximum of 30 sq. ft. of sedimentation tank area for every ton of dry solids present in the sludge.

If the elutriation plant and vacuum filters are to be operated but 8 hours daily (which may be necessary in relatively small plants and in those operating without sludge incineration), the area of the elutriation tanks will have to be correspondingly increased. In any case the detention period of the diluted mixture in sedimentation need not exceed 4 hours in each tank.

In the attached diagram each tank is 22′ inside diameter and 10′ deep. The area of each tank is therefore 380 sq. ft. On this basis, about 12.5 tons of dry sludge solids can be handled in these tanks in 24 hours. In a treatment plant having primary sedimentation and digestion only, this tonnage represents the average digested sludge solids from about 400,000 inhabitants. In a plant having primary sedimentation, digestion and biochemical oxidation, the 12.5 tons of dry sludge solids may represent the digested sludge solids from about 240,000 inhabitants. The population served will depend on the digested sludge solids produced per capita. It will therefore be seen that the sedimentation tanks necessary for elutriation are of minor dimensions.

Size of Mixing Tanks.—The detention period of the sludge and water in the mixing tanks need not be over a minute or so when proper means are used for thoroughly mixing the sludge and water. The tanks shown in the diagram are 2 feet wide, 4 feet deep and 11 feet long, with an effective water depth of 2.5 feet.

Special Features

In the installation at Washington, D. C., the piping between the digestion tanks and the elutriation tanks is so arranged by cross connections that the sludge can be elutriated either intermittently or continuously by single stage, fractional or counter-current methods. Provision is also made for feeding the digested sludge to the filters without elutriation. The elutriation and vacuum filter installations will be operated but about 7 hours daily, therefore the elutriation tank area is larger than would be necessary for longer daily operation.

At Winnipeg, similar piping arrangements are used, although the plant will be practically continuously operated.

In any installation some cross connections with proper valves can be provided. For example, if the overflow launders of both sedimentation tanks are connected to the pipe leading to primary sedimentation, and fresh elutriating water is introduced to both mixing tanks, and mixing tank 1 is shut off by means of a valve from its connection with the overflow launder of sedimentation tank 2, the inflowing digested sludge can be given two fractional washes with fresh water. This will increase the water consumption, but the same elutriation efficiency can be obtained. If, with this arrangement, the sludge draw-off lines from both sedimentation tanks are connected to the same plunger pump, which in turn has a special discharge connection to the vacuum filters, and the inflowing digested sludge and fresh elutriating water can be fed to both mixing tanks, single-stage elutriation with larger volumes of elutriating water can be practiced. This will permit handling a much greater amount of sludge in the same tank system in the same time, for then the digested sludge will pass through the tank system but once. All of these connections are provided in the Washington installation. They are not all recommended for continuously operated layouts and not actually necessary for semi-continuously operated layouts.

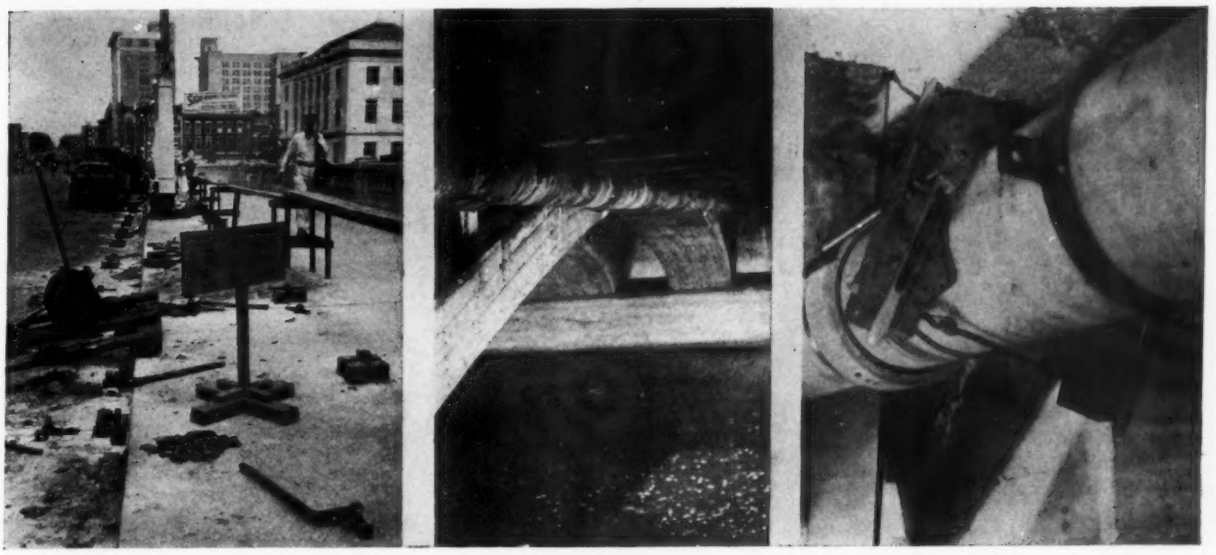
In any installation that may operate on raw sludge or partially digested sludges, especially semi-continuously, a cross connection between the elutriated sludge draw-off lines of the two sedimentation tanks should be provided. On starting operations after a prolonged rest period, this will permit the operator to disconnect the sludge pump from tank 1 and connect it back to tank 2, so that the sludge that was left in this tank can again be washed in both tanks. In washing partially digested and raw sludges, such an operation may be essential to rid the sludge of the effects of progressive decomposition of sludge solids that has taken place during prolonged rest periods.

Coagulant Addition. — Elutriated sludges require little coagulant, and this coagulant reacts much more rapidly with the sludge solids than is the case with unelutriated sludges. Therefore provision should be made at the filters to feed the liquid coagulant in more dilute condition than is required by usual practice, and the properly mixed sludge and coagulant should reach the filter not later than two minutes after adding the coagulant. Prolonged stirring of coagulant into the sludge before filtration is detrimental to producing good filtration results. This applies to coagulant addition to all sludges, whether elutriated or not, but with unelutriated sludges considerably more time is required for the proper coagulation and chemical precipitation, and therefore the usual time for stirring of the coagulant into elutriated sludges before filtration should be shortened.

Elutriating Water.—The savings in chemical resulting from sludge elutriation will vary somewhat with the grade of water used. Laboratory investigations show that even sea water will produce good results. However, a water free from clay and ammoniacal compounds and bicarbonates produces the best results. For digested sludges in plants having biochemical oxidation of the plant effluent, the final plant effluent makes excellent elutriating water, and the effluent from plants having chemical precipitation is good. If the effluent from primary sedimentation is the only water available for elutriation, the savings in coagulant will be very material although somewhat less than when using the purer types of water. Remarkable savings in chemicals can also result from elutriating raw sludges with water which is practically free from disturbing compounds. Good well water or other natural water is the best for this purpose. However, due to the fact that elutriation can effect a reduction in the cost of heated digestion space, better total disposal economies result by adopting rapid sludge digestion and elutriation wherever vacuum filters are to be used.

Chlorination.—As the elutriate from digested sludges is alkaline and contains dissolved ammonium bicarbonate, and chlorine reacts with such alkaline solutions to form chloramines, there are good arguments in favor of chlorinating the returned elutriate for sewage disinfection purposes.

Research at Baltimore shows that after adding ferric chloride to elutriated digested sludges, most of the added ferric salt is found in the ferrous state in the filtrate from vacuum filtration. As the B.O.D. of this filtrate is low, a number of filtrate samples have been chlorinated to re-oxidize the iron present. Returning this filtrate to elutriation produces good flocculation in elutriation, a clearer elutriate and a further reduction in the amount of final coagulant needed. The elutriate and vacuum filtrate may also be mixed and chlorinated and returned to primary sedimentation in order to flocculate and remove more colloids from the raw sewage. There are, therefore, possibilities that chlorination equipment may be of aid to further sewage purification when used with elutriation.



Left—Deck of bridge, showing heads of rods supporting scaffold underneath; also pipe hanger rods near curb. Center—Pipe in place, insulated with 1″ felt under waterproof covering. Right—Steel hanger and device for pulling coupling on pipe.

Water Pipe Suspended from River Bridge at Cedar Rapids

By H. F. BLOMQUIST

Superintendent of Water Works, Cedar Rapids, Iowa

VARIATIONS in air temperature of nearly a hundred fifty degrees, and temperature change of the water in the mains of nearly fifty degrees within six months, together with the high cost of rock excavation for a pipe trench in the bottom of the Cedar River where the water is from one to ten feet in depth, were factors considered by the water department of Cedar Rapids, Iowa, in determining whether to suspend a sixteen-inch water pipe line under the deck of a concrete bridge, where it would be exposed for 700 feet to these extreme temperature changes, or to lay it in the bottom of the river at a much greater cost. The high velocity of the river during floods and the irregular contour of the bottom prevents submerging a pipe line here without trenching. At rare intervals, the air temperature in this locality drops as low as thirty degrees below zero, and at the same time the water temperature may be very little above freezing. Therefore, some insulation to modify frost action was deemed necessary for a suspended pipe. Also, adequate facilities would have to be provided for expansion and contraction of the pipe without causing leakage.

After considering the factors involved, it was decided to suspend the pipe from the deck of the bridge between two rib arches. Consideration of various pipe materials led to the adoption of asbestos and cement pipe known as Transite pipe, partly because of its greater thickness and for possessing some insulating quality against frost, and partly for the type of joints used with this pipe. We considered sleeves and live rubber gaskets would permit movements in the joints without leakage.

The method used for building and supporting the scaffold and for handling the pipe during construction may be somewhat novel in that practically all the work was done from the bridge itself without staging or supports from the river bottom.

The bridge consists of six arches of 103 feet clear span each. The material for the hanging scaffold for one span was made up at the shop and hung from the deck of the bridge with one-inch steel rods extended through holes drilled through the slab. One row of holes were in the sidewalk slab and the other in the driveway paved with brick. The holes were later filled with cement and pavement bricks replaced in the driveway. The hanging of scaffold and handling of pipe were done with the aid of a light scow anchored under the bridge and an air hoist on the bridge. The material was lowered over the bridge railing to the floating scow from which it was picked up and lifted in place by the air hoist with the lifting cable running through holes drilled through the deck. The work was completed one span at a time and the scaffold moved to the next as the work progressed.

Hangers made of ½″ by 3″ band iron each suspended with a 1¼″ rod, were used for supporting the pipe directly under a series of concrete beams on 7′-10″ centers at right angles to the pipe line. Two hangers for each length of pipe were placed near the cross beams and waterproofed cork cushions one inch thick were placed between the pipes and cross beams, and the hanger supports tightened so as to draw the pipe firmly against the cork cushion to prevent movement. This would hold each length of pipe firmly and cause expansion and contraction to take place in all joints instead of accumulating only in a few. One-inch hair felt insulation was wrapped around the pipe and covered with a heavy waterproof roofing felt with cemented laps and copper bands.

The work was done by the Water Department's construction crew, under the direction of B. F. Hazen, superintendent of construction. The pipe line was placed in service September 1, 1936. To date it has been exposed to temperatures from 12° below to 90° above zero without any visible leakage.

An 8-Community Sewage Project

A WPA SEWERAGE project has been constructed in Delaware County, Pennsylvania, which has a number of features of interest to sewerage engineers and other public works officials.

One of these is the fact that the work was done by the combined action of eight communities, which formed a joint agency for carrying out the work, known as the Central Delaware County Sewer Authority. The project consists essentially of tieing together a large number of individual sewers which had been discharging the sewage of the eight communities into three streams—Crum creek, Little Crum creek, and Stony creek—and carrying the total sewage flow to a treatment site and an outfall into the Delaware river. The construction of the treatment plant was postponed for the present.

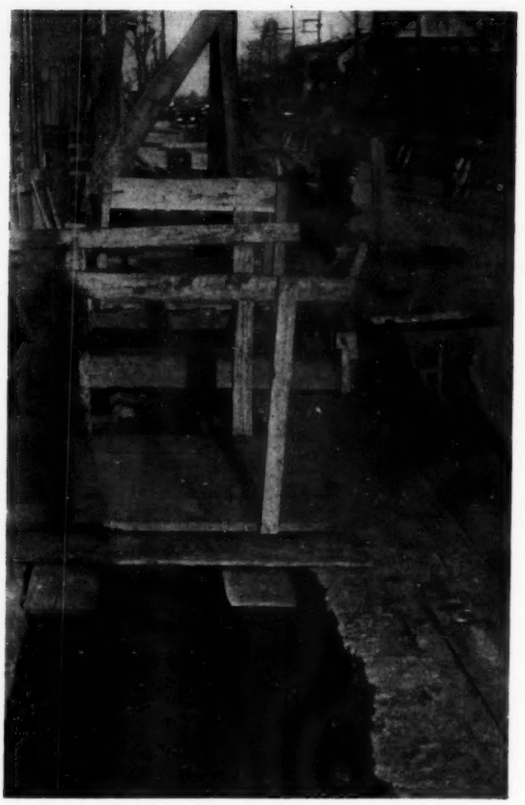
The project was divided topographically into three sections; an interceptor along Crum creek, receiving sewage from Prospect Park borough, Ridley township, Nether Providence township, and Springfield township; one along Little Crum creek, receiving sewage from Swarthmore borough and part of Ridley Park borough; and one along Stony creek, receiving sewage from Morton, Rutledge, and Ridley Park boroughs.

The three interceptors are built down their respective creeks to their intersection with the Chester Pike, where a collector main receives the sewage and delivers it to a transmission main that carries it to the treatment plant site. Here a tee is inserted in the main to provide for a by-pass; which by-pass will serve to carry the sewage to the outlet until the plant is built.

A near-by low area, occupied by the General Steel Castings Co. and a community of residences, is too low to discharge by gravity into the treatment plant, and is drained by a 24″ collector to the by-pass. In this the sewage can at present flow by gravity to the outfall sewer; but, when the plant has been built, a pump at the junction will raise it into the plant, using this part of the by-pass as a force main, while the plant effluent will flow into the by-pass below the pumping plant.

Considerable sections of these several sewer lines were constructed under difficulties, largely topographical. At several points the sewer was laid above the surface, and

Sewer construction above ground.



Pipe laid under narrow sidewalk.

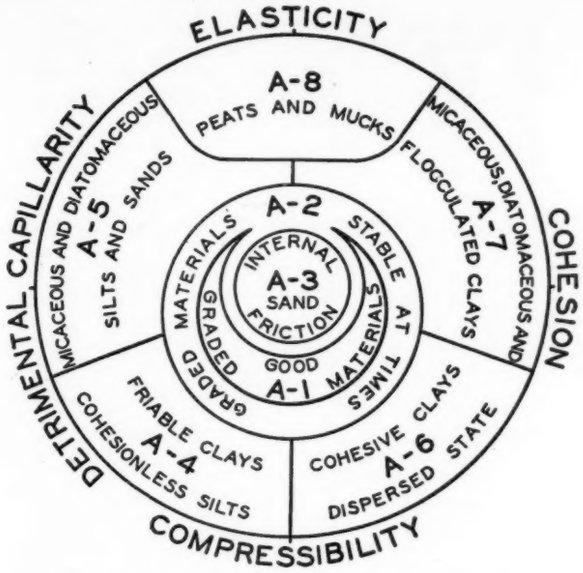
here cast iron pipe was used, supported on piers. Cast iron was used also at two creek crossing on the by-pass, where the soil was gumbo clay, with occasional rock ledges necessitating blasting; tidal fluctuations of the stream adding to the difficulty. Since it is to be used as a force main, the by-pass also is of cast iron, as is the collector bringing sewage to the by-pass.

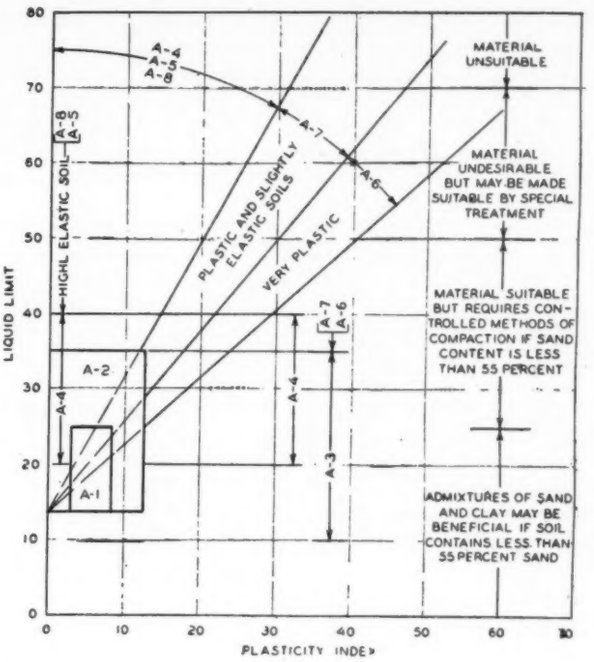
In addition, 24″ cast iron was used for the line connecting the three interceptors to the sewer already existing in the Chester Pike. This sewer was so near the surface that it had been built as a rectangular box of reinforced concrete, 7 ft. wide by 18 in. high, the roof of which served as the base for the pavement, the surface of which was laid directly on it. This same construction was used for part of the transmission main also, other parts of which were of 30″ cast iron.

Parts of the transmission main encountered a further difficulty — that of obtaining right of way through streets. It seemed desirable here to lay the sewer in the sidewalk area, although detours into the roadway were necessary to avoid weakening foundations of adjacent structures. The sidewalks were very narrow, with no parkways, and the excavation occupied practically their entire width.

An interesting feature of the construction of the Crum creek interceptor, which was wholly of cast iron, was the delivery of the pipe. Delivery by trucking would have been very difficult, so the contractor rigged up a small box-like scow which would hold three lengths of pipe and still float in the creek, which in places was only 18 in. deep. This scow was towed by a launch and the pipe unloaded along the side of the trench. This scheme was devised by the WPA superintendent, E. Watson Davis, of Upper Darby.

The consulting engineers for this work were Damon and Foster, of Sharon Hill. The cast iron pipe and fittings were supplied by the U. S. Pipe & Foundry Co.





Above: Fig. 1. Diagram illustrating characteristics of uniform subgrade groups. Right: Fig. 2. Characteristics of groups A-4 to A-8.

Utilizing Soil Tests for Road Construction Data

C. A. Hogentogler, Senior Highway Engineer, and Clement M. Johnson, Junior Civil Engineer of the Bureau of Public Roads, were authors of a paper "Significance of Plasticity Index in Soil Stabilization" which was presented before the Association of Asphalt Paving Technologists at the recent meeting in New Orleans. In this paper were given the details of apparatus and methods for testing for plasticity; also many other data which are technical in nature, and have been omitted from this article, which gives only the conclusions regarding the use of such data for actual road construction.

GROUPING the various types of soils as shown in Figs. 1 and 2 facilitates utilization of test data in road work. The classification is convenient but not rigid. Exceptions, likely to be on the safe side, are due principally to the presence of natural soil cements not disclosed by the plasticity tests. The identification card, Fig. 1, is a simplified and slightly modified form of the chart originally shown in *Public Roads*, July, 1931. Experience since that time has disclosed the need for the slight modifications.

The groups may be briefly described as follows:

Group A-1. Graded mixtures suitable for base courses and good road surfaces for climatic conditions of the Atlantic Seaboard. Indicated by liquid limits, 14 to 25; plasticity indexes, 3 to 8; and grading as follows: clay, 5 to 10 percent; silt, 10 to 20 percent; sand, 70 to 85 percent, with about half passing the No. 10 and retained on the No. 40 sieve. Aggregate passing the 1-inch sieve generally and retained on the No. 10 sieve, up to about 50 percent of the total mixture, improves the stability and abrasive resistance.

Group A-2. Graded mixtures with 55 percent or more sand or similar granular material and liquid limits 14 to 35. There are two varieties: Friable, with plasticity indexes, 0 to 6; and plastic, with plasticity indexes 7 to 15 inclusive. Both are suitable for subgrade, embankments and the like with all good methods of construction.

With grading approaching that of group A-1 materials, friable A-2 soils are generally suitable for stabilized road surfaces and bases in the wetter climates, and the plastic varieties in the more arid regions. Mixtures with silica clays, cherts, caliches and the like, indicated by high cohesion indexes, should be designed with care with respect to climate because suitable surfacing mixtures generally have plasticity indexes higher than those suitable for bases.

Group A-3. Cohesionless sands. Excellent subgrade, little or no silt, no clay; liquid limit 10 to 35; plasticity index 0.

Group A-4. Silty soils with less than 55 percent of sand. Lose stability at locations of frost and thaw and may erode on slopes generally. Otherwise make stable fills and excellent subgrades.

Indicated by liquid limits 20 to 40, with plasticity indexes as shown in figure 2.

Groups A-5 and A-8. Highly elastic materials with less than 55 percent of sand. Elasticity in A-5 soils caused by presence of inorganic material, in A-8 soils by organic material. Indicated by liquid limits generally above 40 and plasticity indexes as shown in figure 2. Erode readily and are affected by frost. Liquid limits above 50 indicate especially poor subgrade. Use should be guided by local experience.

Group A-6. Subject to volume change but contains enough clay to eliminate elasticity. Indicated by liquid limits generally greater than 35 and plasticity indexes

as shown in figure 2. Soils with liquid limits up to 50 are suitable, with proper construction methods, for subgrade and embankment.

Group A-7. Subject to volume change and are slightly elastic. Indicated by liquid limits usually greater than 35 and plasticity indexes as shown in figure 2. Slightly less suitable for subgrade and embankment than A-6 soils.

Generally the most conspicuously expensive failures in highway work have been of two kinds: The landslides, fill failures, and destructive road surface distortions associated with the use of soils having the high plasticity or elasticity indicated by liquid limits greater than about 70; and the traffic hazards and road destruction due to frost and thaw associated with the use of soils consisting principally of silt and clay and having relatively little or no plasticity.

Gradual settlement of fills, progressive failure of slopes, increasing roughness with localized failures in flexible pavements, unusually high joints and other distortion in rigid pavements are generally associated with the use of fine-grained soils having liquid limits above about 50. These are costly failures also, but are less conspicuous because the expense they entail is as a rule spread over a period of years as maintenance charges.

As a generalization, then, it would seem that all soils with liquid limits of 70 or greater should be avoided because the expense of treatment to make them suitable is likely to be prohibitive.

Soils with liquid limits 50 to 70 involve risks warranting use of better materials when available, for use in fills and cover on subgrades. Especially in the higher fills is trouble likely to occur. When no better material is available, special methods based on local experience should be employed.

Soils containing less than 55 percent of sand are made more suitable by controlled methods of compaction when the liquid limits range from 25 to 50, and by admixtures or coverings with sand materials (or possibly by drainage at locations of probable frost heave) when the liquid limits are less than 25. Soils containing more than 55 percent of sand are generally suitable for subgrade and fill with all good methods of construction.

Regardless of the expense involved in treating the unsuitable soils or substituting better ones for them, their use invites failure and risk of greater cost. This does not mean that every foot of road surface constructed on them will fail, or that failure will occur within any specified length of time; but over a period of years, and especially after long periods of very dry weather followed by prolonged seasons of precipitation or periods of unusually severe frost, enough roughness, with more serious localized trouble, in sufficient length of road surface to warrant new construction, is likely to occur.

Better material, if available, should be substituted for soil of poor quality in fill construction. When the presence of unsuitable materials is disclosed by preliminary soil surveys at locations of proposed cuts, the grade or alignment may be changed. Otherwise, landslides may occur with much property damage and high cost of maintenance for years.

In subgrades, unsuitable soils may be covered with better materials or improved by admixtures of granular material. Improvement by chemicals and bituminous binders and portland cement offers excellent promise for subgrade treatment, but as yet have been used principally in the stabilization of road surfaces or bases.

The simple and inexpensive plasticity tests supplemented by the mechanical analysis, and at times by the field moisture equivalent and compaction tests, serve excellently to disclose the properties of soils for use in soil road surfaces, base courses, subgrades and fills, and to disclose how the unsuitable soils may be improved.

Thought of immediate cost, not lack of knowledge of soils, has delayed and discouraged the construction of adequate subgrades and fills. No one hesitates to construct a bridge when a stream is encountered; special construction is just as necessary when an unsuitable subgrade soil is met. Only part of the trouble can be corrected by making the wearing course or pavement stronger.

We can make use of granular materials, natural topsoils, waste quarry products and the like with confidence. Information now available indicates that even very unstable materials can be made into excellent subgrade by the introduction of a sufficient amount of granular material. Had such poor soils been improved wherever used as a subgrade in the Middle Atlantic States, much of the damage due to frost and thaws which occurred there during the past two winters would have been prevented.

Average Costs of Concrete Pavement Construction in New York State

During the 16 years, 1920 to 1935, the average contract cost of concrete highways constructed in New York State, according to the annual report of the Division of Highways, was:

Year	*Miles*	*Average Cost Per Cu. Yd. of Pavement, Including Cement and Steel. Reinf.*	*Average Cost Per Mile Pavement Only*	*Average Cost Per Mile Pavement Complete*
1920.....	67.60	$17.85	$26,382	$31,569
1921.....	68.09	15.00	25,012	30,134
1922.....	65.01	13.62	22,905	27,945
1923.....	136.24	15.09	32,010	39,538
1924.....	169.67	15.65	32,808	42,179
1925.....	216.33	15.38	33,389	44,238
1926.....	241.94	14.56	35,782	47,570
1927.....	312.04	12.04	36,259	48,957
1928.....	334.37	12.90	35,689	49,658
1929.....	317.05	11.76	35,083	48,971
1930.....	383.92	11.49	35,683	49,264
1931.....	454.10	10.08	29,673	42,900
1932.....	200.99	7.97	21,446	30,452
1933.....	227.395	9.45	27,095	37,987
1934.....	129.20	10.02	29,877	45,399
1935.....	117.64	9.89	28,559	47,757

The mix during these 16 years varied between 1:1½:3 and 1:2:4. Pavement thicknesses varied from 5 in. to 8 in. During recent years there has been a tendency to increase the amount of reinforcement per cubic yard.

Contractor's Right to Rescind Highway Contract

In an action for damages for breach of a highway contract by the state, the New York Appellate Division, Luciano v. State, 287 N. Y. S. 768, held that, the state having breached the contract by refusing to give the contractor possession of the highway on which the contract was to be carried on and by changing the method of curing the concrete and by refusing to pay for the change and to give the contractor a supplemental contract as required by law, and by refusing to pay for the work already done according to the terms of the contract, the contractor was justified in rescinding the contract and suing for the value of the labor and materials which he had expended upon the contract. Judgment for plaintiff in the state Court of Claims was affirmed.

The Editor's Page

House-Trailer Sanitation

Frank R. King, Supervisor, Bureau of Plumbing and Domestic Sanitary Engineering, Wisconsin, says that if the popularity of house-trailers continues to increase at its present rate, Wisconsin will soon be faced with a new sanitation problem. Many trailer models feature toilet and kitchen facilities, but few of them provide for retaining wastes until they may be disposed of in a sanitary manner.

Many tourist camps in Wisconsin maintain permanent sanitary facilities capable of serving trailer dwellers, but many municipalities have already recognized in these rolling homes a menace to public health that may require new ordinances for its proper abatement.

The city of St. Petersburg, Fla., enacted an ordinance in October, 1936, aimed at insuring proper sanitary conditions for trailers occupied within the city limits. This ordinance restricts occupied trailers to licensed camps, and it illustrates a practical method of enforcing trailer sanitation within a municipality; but rural localities lacking modern sewage and sanitation ordinances may find trailer sanitation a puzzling problem in public health.

Old Man Diversion Again

The present agitation in Congress over granting federal funds to states that persistently divert large portions of their road moneys to other purposes is most laudable. It ought to succeed. Two of the states that would suffer would be New York and Masachusetts, though there are plenty of others, too.

According to figures compiled by the Bureau of Public Roads, Massachusetts diverts nearly 60% of its gasoline taxes to other purposes, and New York diverts *only* 70%.

This seems to be the record to date. We would dislike to have one of our readers tell us that his state was over the 70% mark, but if he can produce the evidence, we'll publish it.

The Need for Education in Highway Matters

As PUBLIC WORKS sees it, a sound highway program includes in essence, the following: The development of a comprehensive system of highways, including both primary and secondary roads—the latter to include all roads serving rural areas; and a reasonable gasoline and motor vehicle tax, with the entire income from this devoted to highway construction and maintenance.

According to the National Highway Users Conference, more than 5,000 bills relating generally to motor vehicles and highway use have been introduced into the various state legislatures since January 1. About 2,000 of these relate to taxes and fees.

These facts emphasize the necessity for continuous education of the public and of the lawmakers, as well as of the engineers and officials who have to do with roads. There can be no let-down; the public forgets quickly, and new lawmakers are continually taking the place of old.

PUBLIC WORKS wishes to do its share of this educating, and more. Two years ago last December, we prepared a special message on road construction as an employment aid, which was designed to combat the diversion of road monies, and sent a copy of this to every one of the 7,000 state legislators. Other special messages and articles have been broadcast similarly, and this policy of PUBLIC WORKS will be continued in the future.

But not one nor a dozen publications can prevent diversion legislation unless the voters let the legislators know how they feel about it. And fully 75 percent of the voters are car owners and gasoline buyers. Only a few of the states, and these the smaller ones, do not divert their gasoline funds.

To keep the voter-car-user gasoline tax conscious, we suggest that each gasoline station in diversion states place, adjacent to its gas price sign, another which says: "For every gallon of gas you buy, the state takes 3 cents of your money for non-highway purposes. Tell your representative what you think about it." Keep the votes educated and persuade them to educate their law makers.

Water for Fire Protection Where There Is No Water Supply

There are many small communities which do not feel that they can afford a water supply system, despite the numerous advantages that such a utility affords. For those communities, we call attention to an enterprising town in Wisconsin which has constructed reservoirs for fire protection. These are really concrete cisterns placed two or three feet under the surface of public roads. Capacity is 25,000 to 40,000 gallons.

A source of supply, some pipe and concrete materials are all that is needed. Mix these ingredients with WPA labor, and fire protection is available, pumping engines being spotted over the cisterns in time of need.

It seems to us that if we mixed one good engineer with the above ingredients, a real water supply might result at a very slightly increased cost. Then the community would benefit by fire protection, by reduced insurance rates, by the convenience of water in each home and by better health conditions.

Preventing Heat Prostration on Construction Work

"Heat prostration" isn't the technical medical term for it; the cause is rapid loss of body salts during hot weather through excessive perspiration; the cure is accomplished by adding salt to drinking water, thus replacing the salt lost through perspiration.

Hot weather will soon be coming on. It will be an economy to the employer and a real blessing to the employee to make provision for adding small amounts of salt to drinking water to prevent occurrences of this sort. This can be done most easily and certainly by the use of a proportional feeder that adds a predetermined amount of salt to the water, no matter how much or how little water is being used. A simple layout of this sort will prevent much loss of time if the weather gets really hot.

Mechanical joints provide for temperature changes in exposed pipe

New line descending to make junction with the old one

Emporia Lays 2½ Miles of Main in Two Weeks

By M. DUNSWORTH
Water Superintendent, Emporia, Kans.

IN JULY, 1936, Emporia, Kansas, found itself faced with a water shortage. Its supply is taken from a reservoir created by a dam across the Neosho river, but the flow of this river became so low that the City Commission enforced drastic restrictions on the use of water. Finally when, in spite of this, it was estimated that there was but 30 days' supply left, it was decided to obtain an emergency supply from the Cottonwood river 2½ miles away.

Two years previous, when a similar shortage had threatened, the commission had purchased 13,000 ft. of 10″ mechanical-joint cast iron pipe to be used for this purpose; but while the pipe was on the way rains filled the reservoir and removed the necessity for it. Fortunately it was decided to keep this pipe stored in the city yards in case of similar emergency in the future; and this pipe was used in 1936 in the way originally intended.

Because of the need for haste, it was planned to lay the pipe on the surface of the ground, which meant many irregularities in line and grade and temperature expansion and contraction. It was to meet these three requirements—haste, numerous slight angles in line, and temperature movements at joints—that mechanical joints were used.

The new line was laid from the Cottonwood river 12,300 ft. to a 16″ auxiliary line connecting the city's water plant with the distribution system; the emergency supply passed through 3,000 ft. of this 16″ line and 700 ft. of new 10″ pipe to the treatment plant, from which it was sent to the city through the main supply line.

The new line was laid on the surface except where it crossed roads, driveways and railroads. The construction crews took out and replaced eight small bridges, crossed three highways, and went through two railroad underpasses and a highway culvert. Most of deflections were made at joints, only six special bends being used —three 45° and three 22½. Two crews, working from opposite ends of the line, did all this work, including cutting into the 16″ line and testing the line, in 14½ days. The restrictions on use were then removed.

In testing the new line, 10,000 ft. of it from the new pumps on the Cottonwood river was tested to 200 lbs. pressure. The remainder was tested by gravity from the reservoir at the city plant. The line was found to be tight, and no retightening or replacement of joints was necessary. In service, the line carries an average working pressure of 90 lbs., rising to slightly above 100 lbs. when 1¼ mgd is being furnished.

New York State Bill Would Regulate Water and Sewage Plant Operators

A bill has been introduced into the New York legislature, now in session, giving the Public Health Council authority to prescribe by regulations the qualifications of operators of public water treatment plants, sewage treatment plants and dairy and milk inspectors.

In effect, this bill would not apply to anyone appointed before June 30, 1937, and thus would have the effect of preventing the replacement of existing personnel, unless the new appointee had the necessary qualifications for the work. It would therefore act to prevent the displacement of competent persons, except by others fully qualified for the work.

Typhoid Fever in California, Due to Drilled Well Supply

In 1934 in California there were 626 cases of typhoid fever with 80 deaths and in 1935, 534 cases with 75 deaths. In the spring of 1936 a very interesting outbreak involving 29 cases occurred in a small community in the Sacramento delta region. Investigation proved this outbreak to have been water borne. The water supply was from a deep drilled well, the casing of which had rusted through about three feet below ground level, permitting heavily polluted water to seep in. It was found that a 12-inch sewer line passed within a few feet of the well and every joint leaked. Heavy rainfall raised the ground water level and allowed sewage-polluted water to pass through the well casing into the well. When a new supply of water was furnished the outbreak subsided.

[Ed. Note: Chlorination would have prevented these cases.]

Locating and Controlling Subsurface Structures

Part of a Committee Report Before American Road Builders' Association; Fred Bay, Chairman

THE proper and systematic location of sub-surface structures is a problem with which every city must cope, if not at present, at least some time in the future. The older cities already have their problem to find suitable locations for renewals of existing city structures or to find space for new utility structures in a street almost filled to capacity with sub-surface structures of which there may be very meagre information.

Standard Locations

The adoption of standard locations for sub-surface structures is one of great importance, but only a few cities have adopted standard locations, as to both minimum depth and distance from center line or curb line. Toronto, Canada; Seattle, Washington; Baltimore, Maryland, and Brooklyn, N. Y., have standard locations for most of their sub-surfece structures which are adhered to as far as it is possible to do so.

For years the City of Philadelphia has reserved certain locations in the roadway for city structures such as sewers, water pipe, and gas. On sewers up to 5′0″ x 3′4″, egg-shaped, the center line is located 6′ from the curb line. For larger sewers the nearest outside edge of the sewer is 5′ from the curb line. This practice is followed so that a sewer lateral connection can be made by tunnelling from the sidewalk a maximum of five feet being allowed. For water pipe location, the center of the street has been standard for years, but in new developments service mains are laid in the sidwalk 6′ from the curb for house services. Gas mains were located 3′6″ from the curb line, but in new developments a space of 8′ from curb line in the sidewalks has been reserved for house service. Supply mains for both water and gas retain their locations, but fewer of such locations are required.

In the older cities, owing to the installation of many structures before this subject was given much thought, it is difficult to create standards, but some form of standardization should be determined upon in the newer developed sections of the city.

The use of sidewalk locations for water, gas, communication, and electric service structures is one that has been long neglected and our reports show that in only four cities is it required, although it is permitted in eighteen cities and prohibited in only two cities, and one city reports that permission must be obtained from the property owner.

All the cities report lack of jurisdiction in streets not legally opened, and as to the exclusion of any structures from legally opened streets.

Application for Permit

The necessary procedure that is being followed in the various cities submitting reports shows a common practice is in use.

The applicant must furnish name and address, business, show character of structure to be installed, with plan showing character of paving, location with reference to centre line or curb line of street, and acceptance of all the rules and regulations governing the installation and restoration of street paving.

Five cities do not require the character of paving to be shown, although in all of them the restoration is to be made by the city; and in six cities a signed acceptance of the rules and regulations is not required.

To the question concerning the installation of city-owned structures and the procedure outlined above the replies were practically the same, except that a contract form replaces the application form, some department of the city being the applicant for the location only.

In Louisville, Ky., all sub-surface structures, other than those of the utilities having general franchises and those installed by the city, are installed by authority of a special twenty-year franchise sold for a fixed amount. The city is protected by a bond from damage through construction, operation, and maintenance of these structures.

Approval of Permit

The authority to occupy the bed of a public street or alley with a sub-surface structure varies greatly in the different cities. Of 23 cities replying, 14 state that openings are authorized by the legislative branch. In the others, practice varied.

The franchise in each case gives the owner the right to occupy city streets and alleys, subject to the rules and regulations of the city, and after application for permit has been made final approval cannot be given until certain bureaus have given their approval, this being required in order to protect city structures in the street and to reserve space for proposed future installations.

In New Orleans, owing to topography, the Sewer and Water Board operates as a separate unit from the City government and has prior rights to subsurface space over all persons or public utilities, even though the location may previously have been approved by the city.

In Philadelphia all applications are filed with the Secretary of the Board and it is his duty to make all the necessary investigations and secure the necessary approval from any or all bureaus where approval is required, before the application is submitted to the Board.

Bonds and Other Costs to the Applicant

Thirteen cities require posting of bonds for the faithful performance of the conditions of the permit, but only eight cities require the fee receipts to be produced, while twelve cities charge for their permits. These charges vary greatly. In Manhattan Borough, New York City, old franchises pay a flat rate per annum, a flat rate per linear foot in some cases, and on other structures the rate is according to cross-section area. In Philadelphia a nominal fee for checking plans is charged per running foot, the rate depending on the length of the structure. Surface lines pay an annual amount in lieu of license.

Seventeen of the cities replying to the questionnaire charge for the restoration of the street paving by municipal forces, this being the sum total received by the city.

Permits and Conditions Imposed by Permits

The life of the permit varies from one month to two years, and can be renewed in sixteen cities for varying periods. There are cities where work must be started within a definite period of one or more days, and if not started, the permit is cancelled. The practice of renewing permits in order to hold a certain location indefinitely is permitted in only four cities, is optional in two cities, and is not permitted in eleven cities.

The practice of reserving space for future extensions, provided there is no other applicant for the same space, is permitted in nine cities, and is not permitted in ten cities, and is optional in one city.

During the installation of sub-surface structures the permittee is responsible for any injury to any person or damage to any property.

If the city, in installing its sub-surface structures, encounters privately owned structures, the owner of these structures must relocate them at its expense in seventeen cities. In two, the city pays and in two others it is optional with the city.

It has been the practice in most American and Canadian cities to refuse permits to open streets recently paved or repaved for a period varying from one to seven years, and this practice has been adhered to in regard to utilities, provided that they had sufficient notice prior to the paving or repaving, except in two cities where it is optional, while in two cities permits are issued.

Construction work of any nature must not start without approval of application and granting of permit, but the common practice on emergency work is to secure an advance permit, to be followed at an early date by regular application for formal permit.

As previously stated, most all cities, except Philadelphia, reporting on the question of restoration of paving, restore the paving, particularly asphalt paving, with city forces, and charge the permittee for the same. The restoration of block paving by the permittee is optional in six cities.

The length of guarantee on the restored paving done by the city varies from one to five years, and in Philadelphia, where the permittee restores the paving, the guarantee varies from twenty days to the life of the paving, according to the terms of the franchise.

In Vancouver, Canada, the utility company guarantees the paving indefinitely and no method of backfilling is specified.

Applications received and permits issued are open for public inspection in eighteen of the cities reporting; inspection is refused in only one. Four did not reply.

Recording

Altogether there are twelve cities that require the filing of completed composite drawings. Only seven have already completed, or planned to complete, sets of drawings showing all of the sub-surface structures.

The City of St. Louis keeps complete records of all sub-surface structures in the several bureaus. For instance, the Bureau of Water has all water mains, fire hydrants, valves, etc., used in connection with the water supply. The Department of Streets and Sewers has a record of all sewers, and the Department of Public Utilities has a record of all underground conduits, cables, steam and refrigeration lines; and all changes are kept up to date by each bureau.

In the City of New York, Borough of Manhattan, the plotting of subsurface structures has been discontinued, owing to lack of funds. The system used in New York consisted in mounted matched cards 8″ x 13″ or multiples thereof, but, due to numerous changes in the subsurface structures, the system was unsatisfactory; and they now recommend the use of the 8 x 13 card supplemented by an index card, on which is recorded the changes and the date on which they were made.

The general practice is to have all drawings of the same size and scale, so each drawing can be matched to the adjoining ones; and, except in Philadelphia, the structures are shown to scale and in color. Newark shows structures to scale when the width is over twelve inches and under twelve inches it is shown as a single broken line in colors.

One city submitted to the Committee a drawing showing a full city block with four intersections plotted, which means that each intersection would be shown on four different drawings, and each street would be shown twice. All structures are shown to scale and colored. Another city shows the intersection in the center of the drawing with all the streets extending therefrom for one-half the distance to adjacent intersection. Structures are drawn to scale and in colors.

Newark, N. J. shows one street on a drawing generally two blocks long, showing the intersections at both ends. Structures are drawn to scale and colored, if over twelve inches wide. If under twelve inches wide, the structure is shown by a colored broken line.

Philadelphia, through its long experience in this class of work, abandoned two methods of recording—mounted paper large sheets and bristol board 8″ x 11″ sheets, both in conventional colors and to scale—for its present system—a broken black line on tracing cloth. These tracings cover one city block and the limits are east house line to east house line and north house line to north house line—and no intersection is plotted on more than one drawing. In making changes in sub-surface structures, one plan only requires correction, thus eliminating the chance of error if two or more plans require correction at the same location.

In the older cities, with intricate sub-surface structures, if structures were drawn to scale, the structures would be almost indistinguishable.

Philadelphia has found a great saving in time between the old type of colored structure on a large sheet and the black line layout on tracing cloth of the same size, this saving amounting to as much as seven days per drawing.

All manholes and surface structures appurtenant to the sub-surface structures are shown on all of the above plans.

Very little information concerning the working force employed on this plotting could be obtained. Newark reported twenty men, Toronto six, Washington three, Vancouver two, Seattle one, Philadelphia nine. The number depends on whether new plans are being drawn or whether the completed plans are being kept up to date.

The methods used by the different cities in filing completed construction plans are of two classes. Generally they are filed by location, while card indexing has been adopted by others. In Philadelphia every utility plan is given a number, and is filed in numerical order under the utility company name. The street location is placed on a library card, with number opposite, and all locations on same street are carried on this card, but with this distinction, each utility has a distinctly colored card. Thus one filing cabinet only is necessary and the location is easily obtained by looking in the alphabetical index for proper colored card, and obtaining the plan number.

Sewer Construction Under Difficult Conditions

Equipment used for laying sewers below sea level and in quicksand.

WORK is nearing completion on a system of sewers and treatment plant constructed by contract for Corpus Christi, Texas, much of which was carried several feet below sea level in quicksand or other unstable soil. The total sewerage system constructed (beginning in February, 1936) included 17 miles of collecting sewers, mostly 8″ to 12″, a mile and a half of 36″ outfall, and two channel crossings. The new treatment plant consists of a pumping station, two clarifiers, two heated digestion tanks, sludge bed, four 160 ft. circular percolating filters, and a final sedimentation basin. Work was done under PWA contracts.

In the southwest district, a rapidly growing residential section, 8″ and 12″ sewers were laid in very favorable soil. Here the trenching was performed by three machines; down to 4 ft. depth was cut by a Cleveland wheel-type trencher; for depths from 4 to 8 ft. a Parsons machine was used, and from 8 to 20 ft. an Austin. Each of these averaged more than 1,000 lineal feet a day of two 5-hour shifts. In the west and northwest districts the land was lower and conditions less favorable. Here a Cleveland and a Parsons machine each averaged about 800 ft. a day.

The really difficult conditions were found in what is known as the north beach district. Practically all of the 6 miles of sewer here was laid below sea level, 2,000 ft. of it averaging more than 8 ft. below. In spite of this, the ditch was kept dry for pipe laying by use of the Moretrench system of well points and five Domestic plunger pumps. Fifty-six well points were connected up, their lower ends driven about 4 ft. below the bottom of the trench. The effectiveness of this was affected more or less by tide elevations and weather conditions. All trench in this district down to 6 ft. depth was cut with a Parsons machine, averaging 500 ft. a day; from 6 ft. to 16 ft. an Austin machine was used, a 10 x 12 ft. steel shield being fastened to the boom of the machine to facilitate placing 2″ sheeting, all of this deeper trench being sheeted solid. As soon as the pipe had been laid, the sheeting was pulled and the trench backfilled by means of an Austin backfiller. Under these conditions the average progress was about 125 ft. a day. The pipe here was laid with Kalktite asphalt joints.

The outfall line extended from the pumping station 7,210 ft. across mud flats and 500 ft. under the ship channel at an average flow-line level of —5. The pipe was 36″ precast reinforced concrete, except under the channel where 36″ cast iron with "Simplex" joints was used. The outfall trench was excavated with a ¾ cu. yd. "Northwest" clamshell using double mats. The trench was close-sheeted throughout, using 2 x 12 in. sheeting driven by jackhammers equipped with sheeting heads, air for which was furnished by a Sullivan 220 compressor. The pipe was handled to position in the trench with a skid stiffleg timber derrick, 24 ft. boom, powered by a 2-drum "National" hoist. Average progress was 110 ft. per 18-hr. day.

In carrying the excavation for the pumping station wet well to —14.5 and that for the final sedimentation basin to —10.0, 2″ x 12″ sheeting was driven with a No. 6 McKiernan-Terry pile hammer, soil excavated with a 1¼ yd. "Northwest" clamshell, and the opening dewatered with two vertical shaft electric pumps. In placing the 15″ concrete floor of the basin 10 ft. below sea level, on quicksand, the special precaution was taken of covering the sand with a layer of hay, held down by a floor of 1″ timber, and placing eight relief valves in the concrete floor, which remain permanently to prevent flotation.

As the four percolating filters were all the same diameter, one set of forms was used for all four. The forms for the two digestion tanks were built in 6 x 24 ft. panels and the same set used for both tanks, and also for the sedimentation basin and the two clarifiers, all being the same diameter. Concrete was mixed in a 14S Koehring mixer and most of it placed by means of four towers, the rest with crane and dump bucket.

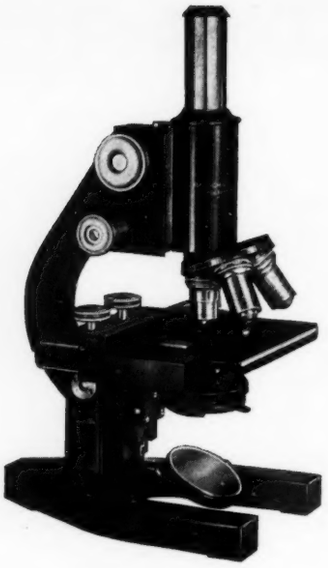
The McKenzie Construction Co., San Antonio, Texas, is the general contractor, with F. S. Oldt as their general superintendent.

Recovery by City for Pollution of Water Supply by Oil Wells

The City of Blackwell, Oklahoma, sued the Arkansas Fuel Oil Co. for its proportion of the damage caused by the pollution by oil companies of the Chikaskia River, destroying the city's water supply and necessitating the building of a new waterworks above the oil field. The Fourth Circuit Court of Appeals, 87 Fed. (2d.) 50, affirmed a judgment for the city in the Federal District Court for Western Oklahoma for $15,000. The other companies had settled claims against them for $70,000. The court put the minimum damage at $128,500. This would place the damage due by defendant at $58,500. As the city did not complain of the amount of the judgment and the oil company had no cause for complaint, the court did not remand the case for inadequacy of damages.

The damage was from salt water seeping through the soil. The evidence showed this will pollute a stream for years, some of the salt depositing in the subsurface water sands, to remain until carried on in wet seasons when the sands are saturated. It was therefore held no defense that the wells were plugged in 1931. Nor was it a defense that the supply was unfit for use during a few months of the year only. A water supply is either constant or worthless. If the city were left without water for a month a year, its people would be at the mercy of fires and pestilence.

The pollution was held to be permanent on the theory that an injury is permanent when its cause cannot be abated by reasonable expenditure. The condition produced by the salt water was beyond repair.



At the left is shown the simple form of microscope used in examining algae. At the right is the Sedgewick-Rafter filter. These cuts courtesy of Eimer & Amend. Illustrations of algae, courtesy Nichols Copper Co. and Dr. Frank E. Hale.

Basic Principles of Taste and Odor Control

By E. A. SIGWORTH
Industrial Chemical Sales Division, West Virginia Pulp & Paper Company

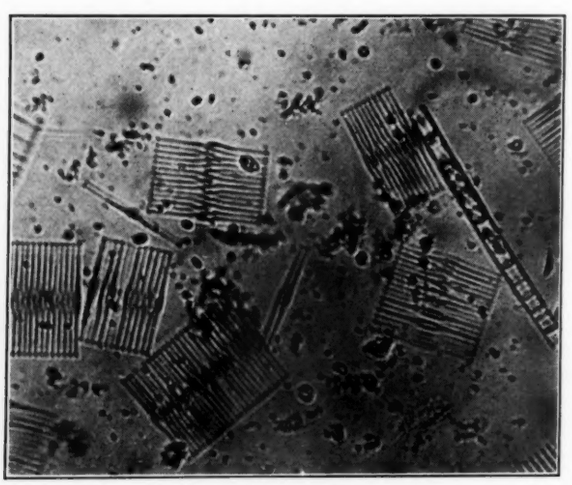
AN UNPALATABLE water, in the opinion of the average layman, is probably contaminated. Moreover, a great deal of publicity has been given recently to the quality of water, so that the water plant operator, superintendent or official has to deal with a very critical public which complains today concerning supplies that a few years ago they would have accepted without question.

While tastes and odors, of themselves, cannot cause disease and rarely even are indicative of dangerous contamination, their presence does represent a real health hazard; for the water supplied by a properly operated water plant is generally the safest possible supply, but when tastes and odor render this supply unpalatable, the consumer is likely to turn to other supplies, often less safe, such as well, springs and bottled water. It therefore becomes the duty of water works officials to protect the health of the community by furnishing not only a safe, but also a palatable, water at all times. It is also good business to do so.

Sources of Tastes and Odors

Plant growths of the algæ type are the most common sources of tastes and odors in water supplies. Some of these organisms, if allowed to complete their life cycle, even if killed after attaining some growth, exude oils or decomposition products which impart a disagreeable taste to the water. Decaying vegetation, such as leaves, grass and moss, is often a contributing cause. These elements are particularly evident when reservoirs are low, and in swampy and stagnant areas.

Very severe and troublesome taste and odor conditions are often due to industrial waste pollution from such industries as coke plants, chemical plants, canneries, tanneries, oil refineries, and dairies.



Synedra Pulchella

Methods of Control

The prevention of tastes and odor in the water as it is delivered to the consumer may be accomplished by preventing the formation or growth of substances that may cause taste, as in the case of algæ; by preventing the entrance of industrial wastes into the supply; by neutralizing or destroying the taste and odor-producing substances; or by removing them. Local conditions will usually determine which of these methods or combinations of them will be most effective and economical.

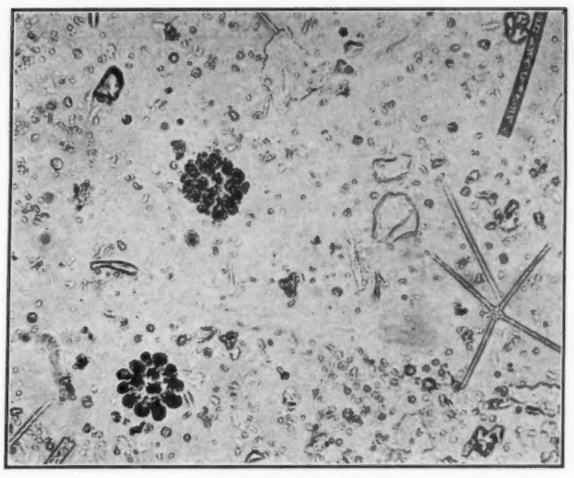
Preventive Measures

The prevention of taste and odor conditions in the raw water supply is the ideal method and every measure possible should be taken to thus eliminate the troubles at their sources. The first step should be a complete and thorough survey of the entire water shed to determine the points where such pollution may originate.

The prevention of trade waste pollution is not often practical, since the expense of treatment, or of adopting some other method of disposal, may be too great for the industrial plant. However, where the waste causing the trouble is only a small part of the total waste produced, it may be practical to dam up this small portion and allow it to discharge at regulated intervals only as when water is not being drawn to the treatment plant. Or the troublesome waste may be so small in volume that it can be stored and emptied during the flood stages when the dilution factor would be very high.

Swampy and stagnant areas on the water shed should be eliminated as far as possible, since decaying vegetation and leaves may contribute high color as well as disagreeable tastes and odors. In eliminating these swampy or stagnant areas, the better procedure is to either fill or deepen them; or to arrange for proper drainage; or channels may be built to carry the fresh water around or through the affected areas; or the

Asterionella



Synura

stagnant water may be cut off by means of dykes or other embankments.

Control of Algae Growths

Sunlight and carbon dioxide are all that is necessary for the growth of algae in water, so that every water works may be subjected to organic growths of this nature. Algae growths are most prevalent during warm weather. Therefore, as the temperature of the water increases in the early summer, frequent periodic examinations of the water should be made so that proper treatment can be instituted *before* the growths have become sufficiently numerous to be troublesome.

It is desirable that such treatment be based on actual knowledge of algae growth conditions, which are best obtained by a simple microscopical examination that determines the kind and number of organisms in the water. If facilities for this examination are lacking, algae control, in the northern part of the United States, should generally start about April 1 and continue till about Nov. 1.

Microscopical Examinations for Algae Growths

The first step in the microscopical examination of water is to obtain a sample of about two liters of the water in a clean container, taken at a point where the organisms will be as representative as possible. The container should be inserted with the neck downwards about a foot below the surface of the water, then inverted and allowed to fill. If it is desired to draw samples at greater depths, special sampling devices are usually necessary. The sample should be examined in 6 to 8 hours; if this is not possible, it should be preserved by adding 20 ml. of formalin for each liter of water in the sample.

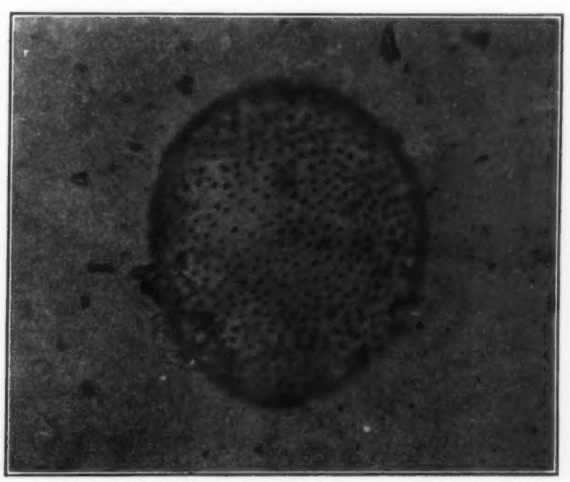
If the sample of water contains a relatively large number of organisms, it can be examined microscopically without concentration. If the number of organisms is small, the sample should be concentrated by filtering or centrifuging. Since the Sedgewick-Rafter method of concentration is simple and inexpensive, this method will be briefly described herewith.

A Sedgewick-Rafter funnel of 500 ml. capacity is fitted at the bottom with a tightly fitting ½-inch one-hole rubber stopper. A small glass U-tube is inserted in the stopper so that the outer arm extends 1 inch above the small end of the stopper. A ⅜-inch diameter cloth disc, preferably of silk bolting cloth, is then inserted, so that it lies flat on the rubber stopper. White sand of 60 to 120 mesh is then poured into the funnel to a depth of ½ inch; 5 to 10 ml. of distilled water is then used to wash down any sand adhering to the walls of the funnel and to drive the air out of the sand.

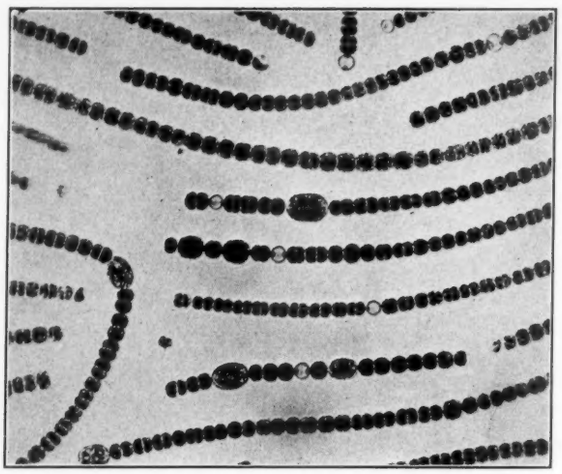
The sample to be concentrated is then mixed by gentle agitation and 250 to 1,000 ml. is accurately measured out for concentration. The size of this sample depends upon the number of the organisms in the sample. The funnel should be held in a slanting position, the measured sample of water poured slowly into the funnel so that the sand layer will not be disturbed, and allowed to filter through the sand. If necessary, moderate suction may be employed. Occasionally during the period of filtration the sides of the filter should be washed down with distilled water. When the water has reached the level of the U-tube, this tube is removed to allow most of the remaining water to drain through the sand.

The rubber stopper is then removed and the sand transferred to a small beaker. The walls of the funnel are washed with a measured quantity of distilled water, say 5 ml., 10 ml., or more, depending upon the concentration of organisms desired. This washwater should be collected in the beaker containing the sand. The water and sand are well, but not violently, mixed and after a moment for settling is decanted immediately into a beaker.

This concentrate is mixed by a rotary motion and one ml. is transferred to a counting cell. The cover glass should then be slid into position so that the entire cell is covered. After allowing this cell to stand for a few minutes, it is placed under the microscope for examination.



Uroglena



Anabaena

The microscope used in the examination should be capable of giving magnifications of from 60 to 400. The degree of magnification to be used will vary depending upon the type of organisms present and whether the organisms are being counted or identified. In the examination of the larger organisms, a low magnification, 48 mm. objective is used. For the counting of small organisms and identification of different types, a 16 mm. objective is used in order to obtain the higher magnification. A field magnification of 75 X to 100 X is usually used.

For the counting of organisms, the cell employed is such that the depth of the sample under examination is 1 mm. The limits of the microscopic field are shown by an ocular micrometer fitted on the microscope. The proper magnification should be such that the stage covered by the micrometer is exactly one square millimeter; and since in the standard field each cell covers 1/1000 mm. of the sample or concentrate, by counting the total organisms in 10 fields, 1/100 mm. of the sample or concentrate will be covered. The 10 fields counted should be well distributed over the entire cell. The total micro-organism count in a sample is recorded as the number of standard units per ml. without regard to the type present. This number is calculated as follows:

$$\text{No. of units counted} \times \frac{\text{total No. of fields in the counting cell}}{\text{No. of fields counted}} \times \frac{\text{ml. of concentrate}}{\text{ml. of water filtered}} = \text{units per ml.}$$

A count of 500 units per ml. will in general cause taste and odor troubles and a count of 400 units per ml. indicates the necessity for treatment.

The cost for the minimum of equipment needed for this work is less than $75. Methods for microscopical examination of water are covered in greater detail in Part V of "Standard Methods of Water Analysis." The identification of algae types requires considerable experience and at first will require reference to illustrations of the various types. Some are shown herewith. A completer treatment will be found in "Microscopy of Drinking Water" by Fair & Whipple.

Copper Sulphate Treatment

Prevention or control of algae is necessary in both storage and distributing reservoirs. Growths may be killed by the use of copper sulphate or chlorine. The latter, while easy to apply within a treatment plant, is quite difficult to apply in reservoirs, consequently copper sulphate is almost universally used for algae control in these. In the table below the more troublesome algae types are listed, with their odor characteristics, and the amount of copper sulphate required for treatment.

It is important that a sufficient dosage of copper sulphate be applied each time the water is treated. Hale† states "It is a waste of chemical to apply an insufficient amount. If a smaller dosage fails, the entire larger dosage must be applied at one time."

The possibility of the dosage of copper sulphate being so high that it would be injurious for human consumption is very slight. A concentration sufficiently high to be injurious to health would have such a disagreeable taste that it would be practically impossible to drink it. However, the dosage necessary for proper

†Director of Laboratories, Mt. Prospect Laboratory, Brooklyn, N. Y.

COPPER SULPHATE REQUIRED FOR TREATMENT OF MICROORGANISMS*

Organism	*Odor*	*Parts per Million*	*Pounds per Million Gallons*
Asterionella	Aromatic, geranium, fishy	0.12-0.20	1.0-1.7
Synedra	Earthy	0.36-0.50	3.0-4.2
Tabellaria	Aromatic, geranium, fishy	0.12-0.50	1.0-4.2
Eudornia	Faintly fishy	10.0	83.2
Hydrodictyon	Very offensive	0.10	0.8
Pandorina	Faintly fishy	10.00	83.0
Volvox	Fishy	0.25	2.1
Anabaena	Moldy, grassy, vile	0.12	1.0
Aphanizomenon	Moldy, grassy, vile	0.12-0.50	1.0-4.2
Clathrocystis	Sweet, grassy, vile	0.12-0.25	1.0-2.1
Coelosphaerium	Sweet, grassy	0.20-0.33	1.7-2.8
Cylindrospermum	Grassy	0.12	1.0
Ceratium	Vile (rusty brown color)	0.33	2.8
Cryptomonas	Candied violets	0.50	4.2
Dinobryon	Aromatic, violets, fishy	0.18	1.5
Glenodinium	Fishy	0.50	4.2
Mallomonas	Aromatic, violets, fishy	0.50	4.2
Peridinum	Fishy, like clam shells	0.50-2.00	4.2-16.6
Synura	Cucumber, muskmellon, fishy, bitter	0.12-0.25	1.0-2.1
Uroglena	Fishy, oily, cod liver oil	0.50-0.20	0.4-1.6
Beggiatoa	Very offensive, decayed	5.00	41.5
Crenothrix	Very offensive, decayed	0.33-0.50	2.8-4.2
Sphaerotilis natans	Very offensive, decayed	0.40	3.3

*Hale, Frank E., "The Use of Copper Sulphate in Control of Microscopic Organisms," Nichols Copper Co., New York.

control of algae growth may be sufficient to kill fish. Therefore, if fish are present in the water to be treated, it is advisable to consult the following table:

DOSAGE OF COPPER SULPHATE LIKELY TO KILL FISH*

Fish	*Parts per Million*	*Pounds per Million Gallons*
Trout	0.14	1.2
Carp	0.33	2.8
Suckers	0.33	2.8
Catfish	0.40	3.5
Pickerel	0.40	3.5
Gold Fish	0.50	4.2
Perch	0.67	5.5
Sunfish	1.36	11.1
Black Bass	2.00	16.6

*Moore, G. T., and Kellerman, K. F. Bul. No. 76, Bur. Plant Indus. U. S. Dept. of Agri. (1905).

Application of Copper Sulphate. 1—The most common procedure is to place the copper sulphate crystals in bags which are then dragged behind boats over the surface of the water. In some cases perforated metal boxes or buckets have been utilized in place of bags as containers for the copper sulphate. Where the body of water is too shallow to allow ready access by boat to the affected areas, or is very small, a bag of copper sulphate has been suspended in the center of an inflated inner-tube and dragged around over the surface of the water with a rope attached to the tube.

2—Pulverized or powdered copper sulphate has been applied by allowing it to drop on a rapidly revolving disc driven by an engine. By this method the small particles of copper sulphate are sprayed out from a boat for quite a distance. This method of application is particularly adaptable to large reservoirs, since treatment is accomplished very quickly and uniformly. By controlling the size of the copper sulphate crystals, a uniform treatment is obtainable for any depth of water. For example, where the water is deepest, larger crystals would be employed so that they would penetrate through a greater depth before becoming completely dissolved. It is reported that this procedure is more economical than dragging bags of copper sulphate over the reservoir, since much smaller dosages can be applied per unit of surface to be treated.

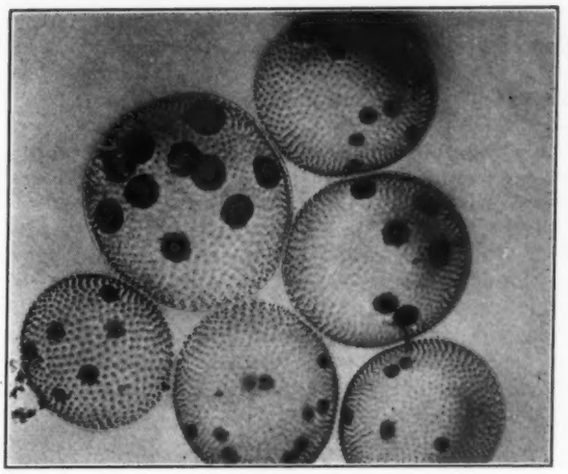
The continuous application of copper sulphate to reservoirs during the warmer months has been reported in several cases with very successful results. The copper sulphate is usually fed as a concentrated solution to the water entering the reservoir.

Since algae growths are more profuse in shallow areas, all of these areas should be reached in the treatment. This can be accomplished by zig-zagging the boat back and forth, gridironing, or otherwise so routing the boat that the paths of travel are 20 to 100 feet apart.

Ammonia-Chlorine Treatment

Tastes sometimes result from a heavy chlorine application, or from the reaction of the chlorine with phenol compounds or with the products of algae decomposition. The use of ammonia in combination with chlorine may prevent or reduce these odors. Ammonia must be added ahead of the chlorine, since if the taste-producing compounds are once formed, the addition of ammonia will not eliminate the taste.

Ammonia is applied as a gas by means of an ammoniator, which looks like and works like a chlorinator; but a chlorinator cannot be used to apply ammonia. The relation of the ammonia dose to the chlorine dose is usually about 1:3; that is, if the chlorine dosage is 0.6 p.p.m., the ammonia dosage will be about 0.2 p.p.m.



Volvox

The additional use of ammonia is advantageous in preventing tastes due to the presence of phenols in industrial wastes; it permits carrying a much heavier chlorine residual without causing taste; and the residual persists longer. Therefore the chlorine-ammonia treatment is desirable in preventing algae or slime growths in settling basins and on filters. Also, it is particularly advantageous in small water supplies where the rate of consumption and of flow varies while the chlorinator setting remains constant; that is, where automatic control equipment is lacking. The heavier dosages of chlorine during low flows will not cause tastes when both ammonia and chlorine are used.

The ammonia-chlorine treatment is also beneficial in reducing deadend troubles, since the chlorine residuals are carried further along in the distribution system and in some cases have presented filamentous growths from occurring in the mains.

It has been reported that the simultaneous application of chlorine, ammonia, and copper sulphate results in the formation of cuprichloramine which is effective as an algaecide.

Corrective Treatment

Preventive measures are not always effective, even though followed out to the minutest detail. When they are not, corrective measures must be used, and the water plant operator should be in a position to employ one or more of the following corrective treatments:

1—Aeration
2—Prechlorination,
3—Superchlorination
4—Potassium permanganate
5—Bleaching clay
6—Activated carbon

Aeration

Aeration exposes a greater surface of the water to air, thereby providing opportunity for the volatile gases, such as hydrogen sulphide and carbon dioxide, to be liberated from the water, thus reducing any tendency toward corrosion. Aeration also permits the oxygen in the air to come in more intimate contact with the finely divided water particles, thus increasing the dissolved oxygen content of the water. The purpose of this increase of oxygen content is to remove the offensive tastes and odors by oxidation.

There are three general types of aerators in use today as follows:

1—The cascade type, where the water is allowed to flow over successive sets of weirs in a step arrangement or past baffles set in the path of the water so that the direction of water flow is continually being changed, the water being agitated meanwhile.

2—The diffusion method, which consists of blowing air under a slight pressure through porous plates which are so constructed that a flow of small air bubbles rises through the water continually. This usually requires a tank construction.

3—The water is discharged under pressure through nozzles so that the water is forced into the air in a fine spray. This is the method that is most commonly used.

The use of aeration for taste and odor removal is decreasing, primarily because it affects only a few of the taste-producing elements, and even these may not be reduced sufficiently to render the water palatable. It should be chosen for this use only after analyses and investigations of the water have shown clearly that aeration will be effective under the conditions that actually exist.

Superchlorination

Superchlorination is the application of such extremely high dosages of chlorine that dechlorination is necessary to reduce the excess of chlorine. Dosages range from 1.0 to 3.0 p.p.m. This method is valuable with certain alkaline waters in which the chlorine, when used in the ordinary amounts necessary for producing a safe water, produces chlorinous tastes. It has also been used successfully with waters containing phenol wastes, as experience has shown that the larger doses of chlorine destroy the phenols, while smaller amounts unite with them, causing tastes. A reaction period of 1 to 2 hours, or even more, is necessary to permit the chlorine to destroy the phenol compounds.

When superchlorination is employed, the excess chlorine must be removed. This is done by adding sodium sulphite, sulphur dioxide or sodium thiosulphate (a relatively simple procedure), or by treating the water with activated carbon, preferably by passing through beds of granular activated carbon.

Prechlorination

Prechlorination, or the application of chlorine prior to filtration, has received considerable acceptance in the past few years. The point of application of chlorine in pretreatment may be any place ahead of the filters. Perhaps the most common procedure is to apply the chlorine in the raw water or at some point in the mixing chamber; the purpose being to give longer sterilizing action. The effectiveness of prechlorination in elimination of tastes and odors depends upon the local problem. In some cases it has been effective; in other cases it appears to have intensified the tastes and odors, creating compounds that, however, are easily eliminated in subsequent treatments. In still other cases the tastes and odors have been so intensified that other corrective measures have been ineffective. Therefore, so far as tastes and odors are concerned, prechlorination should be adopted as a regular procedure only after a thorough investigation as to its effect on the palatability of the water.

Potassium Permanganate Treatment

Potassium permanganate is an oxidizing compound, and is used in taste and odor control to oxidize organic matters that otherwise might absorb chlorine and produce chlorinous tastes. It may also destroy phenolic compounds and eliminate taste from this cause; but when enough is added to accomplish this, it may itself impart a bitter taste to the water. Permanganate is usually applied by solution feed through a suitable proportioning device. The quantity of permanganate to be added depends on the water being treated, but under no circumstances should enough be added to produce a pink color in the filtered water. Dosages of 0.1 to 0.2 p.p.m. are very useful in treatment of waters that have a high organic content, reducing the chlorine demand materially. In amounts not over 0.2 or 0.25 p.p.m., it does not add materially to the manganese content of the water.

Bleaching Clay or Fullers Earth

Bleaching clays have been utilized in several plants for correction of tastes and odors. The removal principle in the case of activated clay is the ability of the clay particles to adsorb the taste and odor-producing substances. The powers of adsorption of the clay particles apparently are limited to a few compounds, especially those present in petroleum refining wastes. If high proportions of clay are necessary to accomplish the desired removal, there is danger of the earth itself imparting a taste or odor to the water.

Activated Carbon

Activated carbon, generally used in powdered form, is applied by means of dry feed machines, solution feed machines or mixed with other chemicals. In feeding activated carbon by the dry feed machine method, it is advisable to have equipment specifically designed for feeding this material, since activated carbons are much lighter and finer than the other chemicals commonly employed in water treatment. The following factors are of importance:

1. Sufficient agitation in the hopper is necessary to insure a constant flow of the activated carbon to the feeding control mechanism.
2. The feeding mechanism should be such that the greatest uniformity of feeding is obtainable, both at extremely high and extremely low proportions.
3. The solution pot should be so designed that intimate and violent mixing of the carbon with the water is obtainable.
4. The carbon suspension coming from the solution pot should be carried away by a water ejector to insure as thorough wetting of the carbon particles as possible.
5. The lines for carrying the carbon suspension beyond the water ejector should be as straight as possible to eliminate the development of back pressure and deposition of the carbon in the lines. Rubber hose has been found to be very effective for carrying the carbon suspension away from the water ejector, since the flows are kept fairly uniform and any deposition of the carbon can be broken loose by a sharp blow on the hose.

Although activated carbons are not soluble in water, solution methods can be employed for feeding. The fine carbon particles are carried in suspension to the point of application. Factors to be considered in utilizing this method of feeding are:

1. When the carbon is introduced to the solution, thorough agitation should be used, since it is quite difficult to completely wet the very small carbon particles.
2. The solution tank should be equipped with an agitator for mixing to prevent the carbon particles from settling out of the solution.
3. Orifice methods for controlling the rate of feed should be eliminated, if possible, as considerable difficulty is encountered with uniform feeding and occasionally there is complete stoppage of the orifice. The most satisfactory procedure employed at the present time is a siphon arrangement working either from a constant-head box or from a float.

Activated carbon has been successfully mixed with alum or lime and fed in the same dry feed machine. Under no circumstances should activated carbon be mixed with any chlorinous compounds such as hypochlorite, as such a mixture may result in an explosion.

Points of Application. Where filter plants are a part of the purification process, activated carbon is applied at any point prior to the filters. It may be applied as a slurry directly on top of the filters, to the filter influent, part way through the coagula-

tion basin, at the entrance to the coagulation basin, in the mixing basins, or the raw water. In general the points of application are divided into two general classifications, namely, prior to coagulation, and following coagulation.

In any case the point where the carbon is to be applied should be such that thorough mixing is assured so that the carbon will be properly distributed throughout the body of water to obtain as intimate a contact as possible of the carbon particles with the taste and odor producing substances present. For example, if it is found that the most effective results are accomplished by application prior to coagulation, the carbon may be applied at the suction side of the pump, as in passing through the pump thorough mixing of the carbon particles with the water is insured.

Due to the variations in types of tastes and odors in water, and in plant design, it is difficult to make definite recommendations as to the most satisfactory point to apply the activated carbon. The following data can be employed for guidance.

After Coagulation. This point is normally selected as the place where activated carbon will have the least work to do, since there is usually some elimination of tastes and odors during the sedimentation process. The conditions for which this point of application is selected are as follows:

1. Where tastes and odors are of only a short duration.
2. Where tastes and odors come up suddenly and have not been noticed until they have penetrated fairly well through the plant.
3. Where tastes and odors are very mild, requiring very small dosages for correction.

Prior to Coagulation. In general this point is selected to insure a longer contact time for the carbon to do its work and to accomplish other incidental benefits. The various conditions for which this point of application appears to be most suitable are as follows:

1. Where tastes and odors occur continually or frequently.
2. Where the organic content of the water is relatively high and may cause tastes and odors due to decomposition within the plant itself.
3. Where tastes and odors are of a severe nature, requiring heavy dosages of activated carbon.

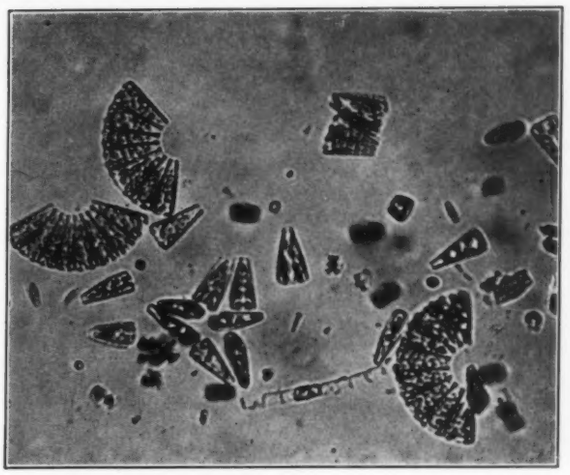
The incidental benefits derived by application at this point are listed as follows:

1. Better coagulation.
2. Better control of coagulation.
3. Greater uniformity in chlorine demand of the water.
4. Stabilization of sludge in the sedimentation basin.
5. Longer intervals between cleanings of the sedimentation basin.
6. The sludge is easier to remove and is practically free of odor.
7. Longer filter runs are obtained.

The above incidental benefits are not always accomplished in toto, but a number of cases have been reported covering each of them, and they are therefore considered worthy of mention.

Dosages of Activated Carbon. The proportions reported in actual plant practice have varied from as low as 1 lb. per million gallons to as high as 560 lbs. per million gallons. However, calculations based on a survey reported in the March, April and May, 1936, issues of PUBLIC WORKS indicates that the average proportion being employed is approximately 16 lbs. per million gallons. It is therefore concluded that the average taste and odor condition in water can be corrected with about 2 parts per million of activated carbon.

Cost of Treatment. Due to the extreme variance in dosages of carbon being employed for correction of tastes and odors, it is impossible to set any definite cost for treatment. With the average dosage above mentioned and the average cost of activated carbon, the cost of treatment approximates very closely $1.00 per million gallons. With this average cost, and basing per capita daily consumption at 100 gallons, the annual per capita cost for activated carbon treatment over a period of one year is slightly over 3½ cents.



Meridion

Reservoir Application. The use of activated carbon in the powdered form is not limited to those plants where sand filters are available for the final removal of the small carbon particles, but it can be applied to reservoirs, the only requirement being that the reservoir so treated be taken out of service for a period of 24 to 48 hours, preferably the latter. The method of application consists of first mixing the carbon thoroughly with water in a suitable container, such as a drum, and then scattering the suspension of carbon over the surface of the reservoir from a boat. The carbon suspension should be so applied that as uniform a dosage as possible is applied to all of the water in the reservoir. In other words, more carbon should be applied at the deeper sections than is applied in the shallow areas. Better settling of the carbon is obtained if the application follows within a day or so a copper sulphate treatment of the reservoir. The only objection to the application of activated carbon to a reservoir which is kept in service is that the small particles of activated carbon will get into the distribution system. This may result in complaints on the appearance of the water for a day or so, but is not harmful in any way to the consumers.

Granular Activated Carbon Filters. Activated carbon in the granular form has been utilized effectively for a number of years in pressure filters supported on sand and gravel beds with suitable underdrain systems, through which water is passed subsequent to filtration. Systems of this type are particularly suited to small water systems, industrial plants, and small municipal installations.

In a recent municipal installation, after pretreatment with powdered carbon to remove the bulk of the tastes and odors, the water is passed through granular activated carbon filters; the double treatment giving an added insurance that a palatable water will be delivered at all times, while the powdered activated carbon serves as an economy measure to decrease the load on the granular activated carbon filters, thus increasing their life.

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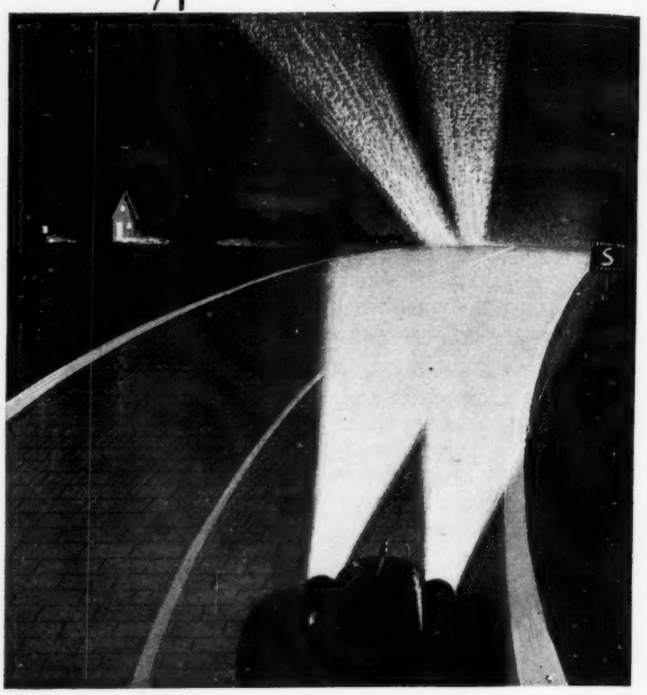

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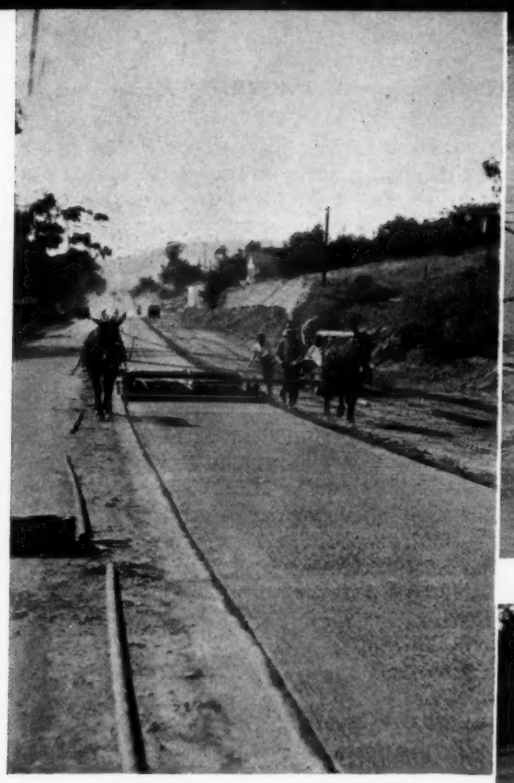

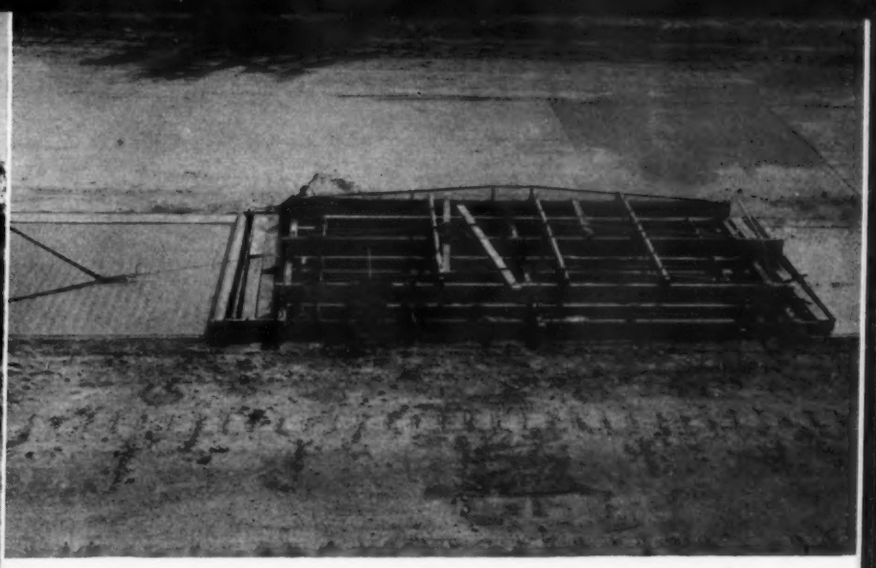

Cuts and Article Courtesy of California Highways and Public Works

Upper right—Close-up view of new type drag finisher being used in road construction by California Division of Highways. Upper left—Showing operation of mule-drawn float which reduces cost of highway finishing. Lower right—Appearance of highway after use of drag finisher.

By H. D. JOHNSON

Assistant Resident Engineer, California Division of Highways.

Drag Finisher for Concrete Pavement*

A RECENT development in the field of finishing Portland cement concrete pavement is a drag float which eliminates the floats and skilled labor ordinarily used behind the mechanical spreader, with the exception of the joint finisher and edgerman.

In 1926, the finishing crew and equipment consisted of one mechanical spreader with its operator and a longitudinal float operated by two men. In 1929, the one-man rib float was introduced and took the place of the pliable float. This released one man so that two ten-foot rib floats were substituted and were used at an interval of approximately 100 feet between floats. Soon thereafter, these 10-foot rib floats were lengthened to 16 feet.

The 16-foot float was a step toward smoother pavements in that it detected long rolling irregularities not revealed by the ten-foot floats, and this also speeded up finishing operations.

In order to secure the maximum subsidence before finally striking off the surface with a float, it was found necessary to hold back on the final floating until the mass of concrete had obtained its set, with the exception of the surface mortar which still preserved its workability due to previous floating operations. This is now known as retarded finish and is accepted as standard procedure on State work.

Two years later, in 1931, a new float was introduced. This was an enlarged rib float weighing around 250 pounds and was drawn diagonally back and forth along the pavement in much the same manner as the blade on a road grader. Because of its weight, it was drawn by a truck or horse by means of a cable approximately 100 feet long, traveling on the shoulder along the outside of the header.

This float further aided retarded finishing by working back of the mechanical spreader as far as 400 feet or more, thus preserving the surface mortar in a workable condition, allowing the rib floats to stay back still further, permitting additional subsidence to take place.

With the approval of the Construction Department, in April, 1935, the drag finisher was first introduced, which works somewhat on the principle of the road plane. It is 20 feet long by 9′-10″ wide, and is drawn back and

*Abstract of an article in "California Highways and Public Works"

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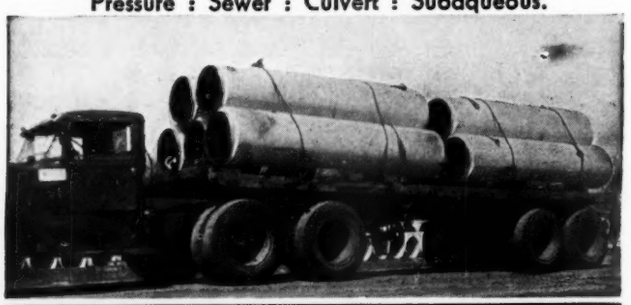

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forth over the surface of the concrete and parallel to the header line. It rides on transverse skids mounted at each end of the drag which has the double function of supporting the machine and striking off the concrete to a plane surface. Between these end skids, a series of cutting blades are set at an angle of 3° with the header line similar to the blades of a subgrader. This blades the mortar into three windrows which are then struck off and smoothed by the rear skid. A roller attached ahead of the front skid brings up the mortar and rolls down the surface rock.

The machine is guided by double-flanged wheels on one side, which act as guides and carry only enough weight to hold them down on the header, otherwise the float works independently of the headers. The drag finisher is drawn back and forth by a tractor or by means of two horses, the tractive effort required being about 700 pounds.

The drag finisher follows the mechanical spreader and is operated over a distance of 300 to 500 feet. Under ordinary conditions it should not operate closer than 100 feet behind the spreader, this distance depending upon the atmospheric conditions and the type of concrete mix used. This float has many advantages over other methods now in use because it reduces the human element to a minimum. It reduces the labor cost of finishing and does better work under adverse conditions. Experiments indicate that this machine could easily handle the capacity output of two one-yard pavers.

One instance in which this drag finisher really proved its worth occurred after a heavy shower which ruined the surface of approximately 700 feet of freshly finished surface. Ordinarily the repair of this surface would require two hours of work on the part of the finishing crew and two hours lost time for the mixer. With the drag finisher, it required approximately 15 minutes to correct the damage and the only additional work required was the refinishing of joints and edges.

The surface appearance of the finished pavement when using the drag finisher differs from the ordinary finish in that the float marks are longitudinal instead of transverse. It gives a better surface because it reduces the element of side skidding and the longitudinal marks are more pleasing to the eye than are the float scars on the average job.

Designation of Diesel Engines in Specifications Not Illegal

In an action to restrain enforcement of an order of the Indiana Public Service Commission authorizing the issuance of municipal waterworks improvement revenue bonds by the city of Crown Point, Indiana, one of the plaintiff's objections was that the designation in the specifications of a Diesel engine for installation to generate electric energy violated Section 48-1904, Burns' Ind. St. 1933, in that one concern only could possibly be a successful bidder, and that was Fairbanks, Morse & Co., to whom the contract was awarded. The Indiana Supreme Court, Letz Mfg. Co., et al. v. Public Service Commission of Indiana, 4 N. E. (2d.) 194, held that no legal objection was shown to the designation in plans and specifications of the term "Diesel" engine. The court said Diesel is a general term, that it is a matter of common knowledge that Diesel engines are manufactured by different persons and companies in many cities in this country, that it was not shown that their designation excluded any bidders, or that other manufacturers of Diesel engines were unable to bid or did not bid.

Following is a digest of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form.

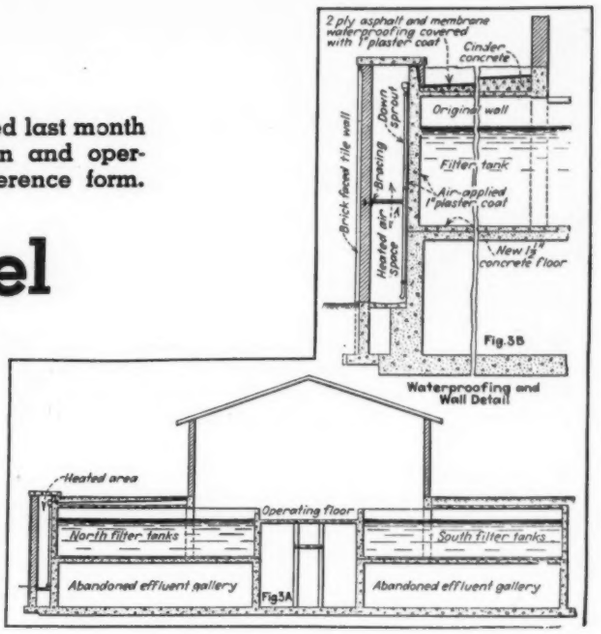
The Water Wheel

Water consumption may be represented by 55 $P^{0.14}$, in which P is thousands of population; for a well metered system this may be reduced to 54 $P^{0.125}$; and for a completely metered low-waste system, 53 $P^{0.11}$. These are based on carefully checked data from 51 representative cities in about half the states in the union and two Canadian provinces, and 107 in New Jersey. The revenue in dollars per capita per year is represented by 7.3 divided by $P^{0.06}$; reduced for metered cities in proportion to reduced consumption. Revenue per million gallons (in dollars) is 365 divided by $P^{0.2}$. The revenue per capita so calculated varies from $7.20 for places of 1,000 population to $4.30 for those of 1,000,000 population, well metered average systems.[A57]

Sub-surface filtering at Toledo, O., began in December, 1935, with reconstruction of a sand filter, increasing sand depth from 24″ to 34″ and raising wash-water troughs 8″. After studying and varying details of filter washing good results were obtained, and better washing than before. There is no evidence of failure of filter heads, clogging of screened section or escape of sand through screen. "The desirability of this system will no doubt be determined by its comparative cost, the difficulty faced by some plants in expanding by the addition of new filters, and whether added capacity by this means is justified at the possible expense of slightly increased effluent turbidity for a short period of time."[A56]

Leaking of filters was caused in a Cleveland filtration plant by frost action and temperature changes. Built in 1916, the filters have leaked at three principal points —through the roof, cracks and porous areas between the floors of the filter tanks and the water surface in them, and from the joint between bottom of tank and concrete base on which they are built. The north filter wall rises 23 ft. above the ground and was exposed to the weather. Air-applied concrete plaster coats 1″ thick were applied to both inside and outside surfaces of this north wall; and to arrest frost action, a new brick and hollow tile wall 12″ thick was built 43″ from and parallel to the old wall and the space between covered with a concrete sab. During cold weather heated air is circulated through this space by thermostatically controlled heaters and electric fans. The result last winter was highly satisfactory.[E11]

Water hammer in a transmission main from pumps of the St. Louis County Water Co. broke the cast iron pipe, split fire hydrants and valve bonnets and did other damage repeatedly. A recording pressure gauge reading up to 230 lb. (static pressure 35 lb.) was burst. The 8″ spring loaded relief valves at the pumping station were complete failures. Corrective equipment comprised two relief valve installations, one at the pumping station to relieve the excess energy of the compressed water



Engineering News-Record

Cleveland filtration building, showing details of tank waterproofing and heated air space.

at the time of the return wave; this was two 8″ x 12″ valves that opened when pressure reached 25 lb. below static, remained wide open for 2 min. discharging 22 mgd. and were closed 5 min. after they started to open. The other installation was at the high point 3,300 ft. from the station, opening to prevent a vacuum and closing after return wave has driven out all the air. "In the operation of electric driven pumps, instantaneous interruption of motivating power can occur.... Rapid closure of the discharge valves in these cases is necessary to prevent reverse rotation of the pumps. Conditions such as these affect no other type of prime mover."[A70]

Filter sand with a low uniformity coefficient for use throughout the entire filter bed is neither necessary nor altogether desirable; for the sand lying in any horizontal plane in a well-washed filter bed has a uniformity coefficient approaching unity, and a graded sand will prevent an abrupt break between sand of the "effective size" and the top gravel layer. A uniformly graded sand will give good results provided the proportions passing a No. 30 sieve are carefully controlled to give a proper filtering layer on top of the filter.

Gravel satisfactory for filters is becoming scarce, which adds interest to the development of filter bottoms which reduce or entirely eliminate the gravel.[A68]

Diesel engines are used either directly connected to the pump, or to drive a generator which furnishes electric energy for pump motors. The former has lower first cost and higher efficiency; the latter is more flexible and more easily adaptable to many existing stations. The majority of diesel-centrifugal units use speed-increasing or "step-up" gears; ex. Nashua, N. H., has 400 rpm. diesel driving 1,350 rpm. centrifugal.

Automatic control can be used to start a cold engine, but most installations are manual starting but automatically stop when water tank is full or engine cooling water supply or lubricating oil pressure is inadequate.[A65]

At Freehold, N. J., an oil engine, in service 8 years,

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was compared with an electric motor, each being operated one month on the same service. Diesel unit cost $12,000, electric equipment $3,000. Fuel oil cost 6 cts. a gallon, current 1.86 cts. per kwh. Interest, insurance, taxes and sinking fund in each case calculated at 11.72%. Fuel cost was $120.36, current cost $719.88. Total cost of pumping per 1,000 gal., 3.97 cts. and 7.53 cts. respectively. Including sinking fund items on idle equipment, 4.97 cts. for diesel and 9.17 cts for electric.[A66]

Chlorine gas discharged into a Chicago waterworks tunnel mixed with carbon monoxide gas infiltering from surrounding soil and formed phosgene, a deadly war gas, which followed a duct to the pumping station. Fortunately discovered and remedied before any damage done. Mixtures of chlorine and ammonia gases or concentrated water solutions of them may, under certain conditions, form highly explosive nitrogen trichloride. A mixture of one part of ammonia gas and 5 of air may be ignited by a spark or high temperature. Ammonia in the presence of moisture is very corrosive to copper or copper-bearing alloys.

Each plant operator should have an individual gas mask, with canister renewed every 6 mos. By standard practice, canisters for chlorine gas are painted yellow and contain a mixture of activated carbon and soda lime; those for ammonia are painted green and contain silica gel. Red is applied to canisters used for both gases, which are not considered so effective as separate ones.

Ropes or wire slings or magnets should never be used in handling containers; hand trucks best for small ones, special lifting rig for ton containers. Scale platforms should be flush with floor so cylinders can be rolled on and off.[A55]

Activated carbon dust is a combustible material (though no explosion of it has been known to occur), and may generate heat by rapid adsorption, especially of chlorine, causing spontaneous combustion, mixtures with hypochlorite of lime may explode violently. Oil or gasoline absorbed by it may cause combustion by heat of oxidation. It should not be stored near heat sources, electric switches, etc.; should be on racks, preferably of metal, 2″ to 4″ above the floor to provide free air circulation and protect it from moisture, and it should be protected from water from leaky roofs (wet carbon cannot be fed easily). For electric wiring, use the National Board of Fire Underwriters code for Class II, Group F, Article 32. Carbon should never come in contact with gases or vapors such as chlorine, sulphur dioxide, gasoline, exhaust fumes from diesel engines, etc., which decrease its efficiency. Should it catch fire, do not squirt or throw water or chemicals on it; isolate it and let it burn itself out, or smother it with water-soaked burlap bags; be careful to do nothing that will scatter the burning particles.[A73]

Equipment improvements have been general recently throughout the waterworks field. Higher efficiencies have been developed in deep well turbine pumps, partly through the use of highly polished surfaces of impellers and in casings, and in some cases by covering the water passages with vitreous enamel. Cast iron pipe, of lighter weight with higher tensile strength has largely displaced the old AWWA standard; for this, Federal Specification WW-P-421 is used by many engineers for bell & spigot pipe, which specification admits De Lavaud and mono-cast centrifugally cast pipe and McWane horizontally cast. Spinning enamel linings in steel

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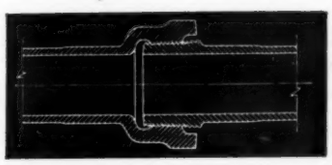

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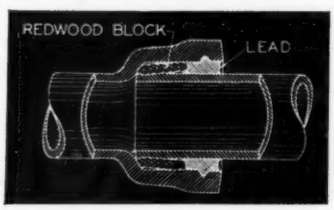

Yes, the Precalked materials are shipped in the bell. Just socket the spigot and calk. Sure! simple! self-tightening! permanent! Serving 25,000,000 ft. of McWane 2″ cast iron pipe from coast to coast!

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pipe, with excellent outer coatings and wrappings, tend to increase confidence of engineers in using such pipe. An important development in valves is the use of square-bottom gates; with sliding shoes, these eliminate fluttering when in throttling position and cutting into the gate seat under high heads. Automatic cone-type plug valves protect pump and piping but are expensive. Automatic control of any part or all features of a filter plant is obtainable and "in many cases automatic control is more reliable and accurate than manual operation."[A68]

Embankment material for a new dam for Little Rock, Ark., must be compacted to give Proctor needle readings of 400 to 2,300 lbs. per sq. in. and dry weights of 110 to 124 lbs. per cu. ft. To locate suitable soil, 989 test pits were dug and laboratory tests made to determine stability and imperviousness under varying degrees of compaction and proper moisture content for each class of soil. These indicated that the soils used weighing 90 to 95 lbs. dry weight will be compacted in the dam at weights between 110 and 120 lbs. Also that the deepest soil at the dam site would settle about 2 ft. if the dam were placed upon it, hence all soil will be removed to bed rock.[A69]

Bibliography of Recent Water Works Literature

c, Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

A *Journal, American Water Works Ass'n*
March

67. Vacuum-Breaker Development for Back-Siphonage Prevention. By F. M. Dawson and A. A. Kalinske, pp. 307-321.
68. Improvements in Water Works Equipment and Materials. By C. I. Dodd, pp. 322-333.

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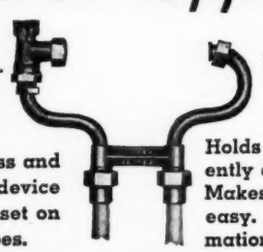

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69. New Water Supply for Little Rock, Ark. By C. A. Smith, pp. 334-342.
70. Water Hammer: Correcting an Unusual Problem. By V. C. Lischer, pp. 343-361.
71. Disposal of Brines from Oil Drilling and Petroleum Operations. By E. Boyce, pp. 362-369.
72. What Becomes of the Water? By H. V. Pedersen, pp. 370-376.
73. Activated Carbon—Its Manufacture and Storage. By J. P. Harris and E. A. Sigworth, pp. 377-389.
74. Determination of the Density of Powdered Activated Carbon. By E. S. Hopkins, pp. 390-391.
75. Taste and Odor Problems. By W. T. Bailey, pp. 392-398.
76. Taste and Odor Problems at Kansas City, Kans. By L. B. Mangun, pp. 399-400.
77. Taste and Odor Problems at St. Joseph, Mo. By J. P. Smouse, pp. 401-405.
78. Tastes and Odors as Found in the Kaw River Water. By F. E. Willey, pp. 406-407.
79. Tentative Specifications for Gate Valves. Committee Report, pp. 408-423.

D *The Surveyor*

February 12

5. *p.* Construction of Large Modern Water Dams. By A. Coyne, p. 271.

February 19

6. Water Supply in India. By F. C. Temple, pp. 309-310.

E *Engineering News-Record*

February 25

8. Developing a New Water Supply for Los Angeles, pp. 285-290.
9. Motor Car for Inspecting Inside of 36-in. Water Main. By H. Wait, pp. 296-297.
10. Filter Sand Permeability Studies. By F. T. Mavis and E. F. Wilsey, pp. 299-300.
11. Heated Air Space Eliminates Frost Destruction in Tank Walls. By L. A. Marshall and H. M. Whitmore, pp. 294-296.

F *Water Works Engineering*

February 17

29. *n.* Manifold for Billion Gallon Aqueduct with Seven Pump Outlets, p. 211.
30. *p.* Water and Its Per Capita Cost. By C. H. Capen, Jr., pp. 212-216.
31. Laboratory Control: Determination of Soluble, Residual Aluminum in Water Coagulated with Alum. By C. R. Cox, pp. 217-218.
32. *p.* Experimental Magnetite Filter Used with Maine Water. By S. I. Zack, p. 223.
33. Hundreds of Millions Required for Water Supply Work, pp. 224, 227.

March 3

34. Cincinnati Without a Water Supply for Nine Days. By W. S. Baum, pp. 264-269
35. *p.* Flexible Face for a Rock-fill Dam. By H. J. F. Gourley, pp. 270-272.
36. Voluntary Licensing of Water Works Men in Texas. By C. Cohen, pp. 273-275.
37. Laboratory Control: Control of Coagulation. By C. R. Cox, pp. 279-281.
38. Mechanical Biller Used by Madison, Wis., Water Dep't. By L. A. Smith, pp. 285-286, 289.

March 17

39. Iron Removal and pH Correction Plant. By J. W. Greenleaf, Jr., and B. F. Snow, pp. 330-334.
40. Water Supply for Louisville During the Flood, pp. 335-337.
41. Hundreds of Millions Required for Water Supply Work, pp. 338-340.
42. Laboratory Control: Control of Coagulation. By C. R. Cox, pp. 342-343, 347.
43. Supplying Water During Flood in Areas Near Louisville. By E. S. Chase, pp. 359-360.

G *Water Works and Sewerage*

March

11. *p.* Experiences with Ferric Chloride at Emporia, Kans. By S. F. Kunz, pp. 81-83.
12. Experiences with Porous Plates for Filter Underdrain at Denver, Colo. By O. J. Ripple, pp. 84-85.
13. A Few Kinks and Gadgets in the Operation of a Water System. By C. A. Hechmer, pp. 86-87.
14. *p.* Experiences in Well Construction. By J. A. Carr, pp. 94-95.
15. *p.* Some Comments on Corrosion in Water Works Practice. By C. N. Alexander, pp. 99-101.

J *American City*

March

5. New Small Filtration Plant Gives Complete Treatment. (St. Elmo, Ill.), pp. 81, 83.

L *Civil Engineering*

March

2. Resume of the Drainage Basin Study Report. By A. Wolman, pp. 167-171.
3. The National Drainage Basin Study. By F. H. Fowler, pp. 171-172.
4. Water Plan for the Red River of the North. By W. W. Horner, pp. 172-174.
5. The Rio Grande Joint Investigation. By H. H. Barrows, pp. 174-175.
6. Collecting and Publishing Hydrologic Data. By T. Saville, pp. 175-177.
7. *p.* The Design of Water-Softening Plants. By W. H. Knox, pp. 199-200.
8. Surge in Water and Sewer Tunnels. By A. B. Morrill and H. Kallgren, pp. 205-208.

M *Canadian Engineer*

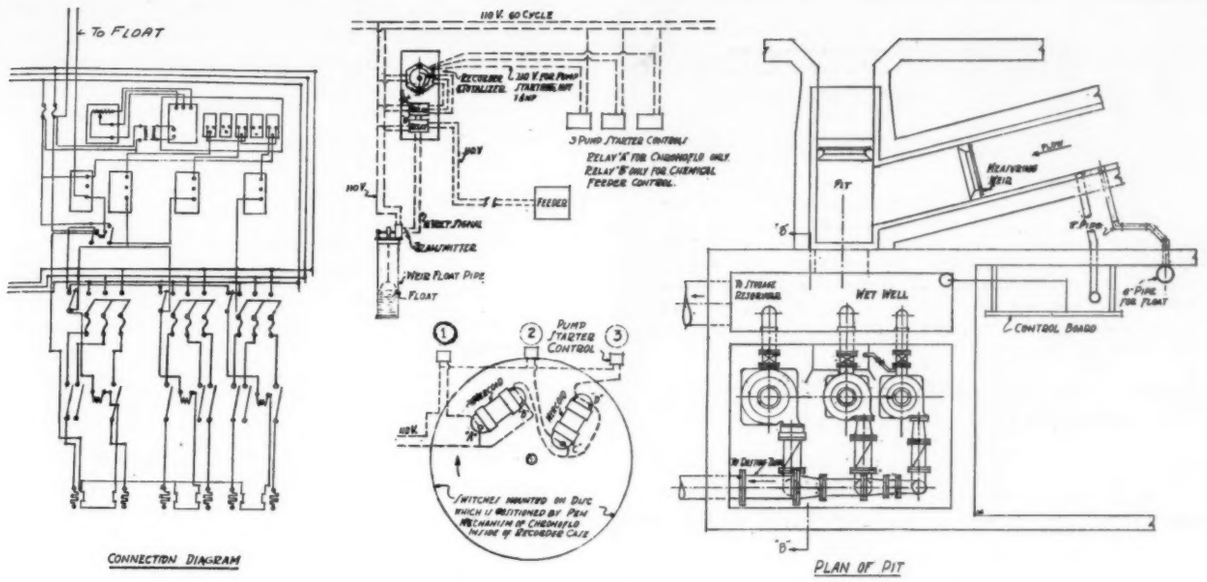
March 9

4. Tillsonburg's (Ontario) New Water Supply Systems. By D. H. Fleming, pp. 3-6.

P *Public Works*

March

17. North Andover's Additional Reservoir. By W. B. Duffy, pp. 9-10.
18. Fifty Essentials of Swimming Pool Design. By C. A. Hyatt, pp. 17-18.
19. Pipe Friction in a New Waterworks System. By R. N. Clark, pp. 20-22.



These drawings of the Ridgewood Pumping Station show the layout of the pit, the general plan of control, the connection diagram and the switch placement.

A New Pump Control

By JOHN W. HOOD
Resident Engineer

AT THE Ridgewood, New Jersey, Sewage Treatment Works, where extensive alterations and additions have been in progress throughout the past winter, an unusual chain of events resulted in the re-design of an existing pumping station. From the resultant study, there emerged a new method of pump control, that seems to possess marked advantages over the conventional wet well type.

The existing installation consisted of two 1,200 G.P.M. wet well type pumps, driven by 5 hp. motors and controlled by float switches from the level of sewage in the well. Due to wear and resultant loss in efficiency, these pumps were being operated in tandem, as neither was any longer capable of handling the entire flow. For all normal flows there was an excessive output, with too frequent off and on operation.

Flow graphs indicated a range of 200,000 to 1,500,000 G.P.D. Consequently a pump having a capacity of 1,440 G.P.M. or 2,075,000 G.P.D. requiring a 7½ hp. motor was selected. A further study of the flow graphs indicated that the average night flow rarely exceeded 500,000 G.P.D. except during storms, and the average flow for the balance of the 24-hour cycle throughout 60 per cent of the year did not exceed 1,300,000 G.P.D.

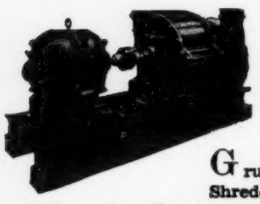
It was therefore decided to select a pump of such capacity as would care for the night flows, and another which would care for the normal daily flows, the combined capacities of which would equal that of the high stage pump.

A low stage pump of 375 G.P.M. or 540,000 G.P.D. requiring a 2 hp. motor, and an intermediate pump of 925 G.P.M. or 1,330,000 G.P.D. requiring a 5 hp. motor were selected to meet these requirements. Where demand load is metered, the advantages of this new pump control are substantial. In this instance, a 2 hp. motor 5 hours each night and a 5 hp. motor, 19 hours each day, both running practically continuously, will do the work formerly being performed by a 10 hp. installation which cut in and out every 4 or 5 minutes.

A bulkhead was necessary in the existing wet well pit to provide a dry pit of sufficient size to accommodate the three-stage pump installation together with the necessary suction and discharge pipe and fittings and control valves. There remained only a very small wet well, and a study of storage indicated that it would be necessary to utilize the existing 24" surge pipe and the underground tank to which it was connected. Exhaustive time studies of pump operation, assuming the combined storage of the small wet well, the 24" pipe and the underground tank showed that throughout the varying flow range an adequate balancing reservoir would thereby be provided. All sludge was removed from the underground tank and pipe and a new concrete floor adequately pitched toward the surge pipe was placed.

There yet remained the selection of the means to operate the pumps based on the high and low levels of the sewage in the wells. A common low level was established and three high water levels were selected to conform to the pumps chosen.

A study of the running time and rest period of the three pumps throughout the flow range, when actuated by their respective high levels and common low level in the wet well disclosed a serious problem. For example, assuming a rate of inflow of 1,400,000 G.P.D. necessitating the operation of the high stage pump of 2,075,000 G.P.D. capacity there would exist a differential of 600,000 G.P.D. which differential would rapidly exhaust the storage in the balancing reservoir down to the low level causing the pump to shut off. The inflow continuing on at the same rate of flow and in the absence of the operation of the large pump, would then rapidly begin to fill the balancing reservoir. First the small



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pump would cut in as its high water level was reached; but being of small capacity, the differential between its output and the inflow would rapidly raise the level to that of the intermediate pump, which would in turn take up a task beyond its capacity and the sewage level, continuing to rise, would then restore the high stage pump to service, and the cycle would commence anew.

The writer felt that if a selection of pumps on the basis of rate of inflow could be worked out automatically, the too frequent off and on operation of pumps and the resultant undue wear on control apparatus and motors and excessive current consumption could all be eliminated, whilst pump efficiencies just as great as a manufacturer could incorporate in his design, would be made available throughout the entire flow range.

Re-design of a flume and weir immediately outside this pump station suggested the possibility of reducing this idea to practice, by selecting and energizing the pump circuit in accordance with the rate of flow as accurately measured over this weir, while actually controlling the off and on operation of the pump by a common low water level and high water level in the storage reservoir, through the medium of individual controls.

From this research there finally emerged a plan requiring but the substitution of standard equipment to reduce it to practice and to terms of dollars and cents. The new pump control may be applied through the medium of standard equipment as manufactured by Builders Iron Foundry, Electric Controller & Mfg. Co., Minneapolis-Honeywell Regulator Co. or W. & L. E. Gurley.

Pump Control Based on Equipment by Builders Iron Foundry

A 2″ pipe connects the flume above the weir, to an 8″ float pipe, on top of which is mounted a float operated transmitter, which conveys signals representing rate of flow through a relay to a recorder and totalizer. Mercoid switches are mounted within the case of the recorder and set to make and break contact within the three bands of flow, representing the three pump capacities. Thus successive pump circuits are energized and de-energized as the rate of flow ascends or decends. In addition, each pump is equipped with a switch actuated by the high and low levels in the wet well, which controls the on and off operation of the pump whose circuit happens to be energized, that is, the one whose output conforms most nearly to the rate of inflow. In addition there is a fourth switch, set to operate at a high water alarm level in the well. This is connected directly to the starters of the low and intermediate pumps and to an alarm bell. In the event the inflow increased, requiring the high stage pump to operate, but for any reason it failed to start, then the rising level in the well, thru the fourth control would start the low and intermediate pumps in unison to do the work. At the same time, the alarm bell summons the operator to remedy the defect responsible for the failure. Of necessity, this fourth, high water alarm control cross connection to the pump starters would intervene between the totalizer device and thus be capable of energizing the low and intermediate pump irrespective of the rate of flow.

Pump Control Based on Equipment by Minneapolis Honeywell

A 2″ pipe connects the flume above the weir and extends to the control board. The control is identical in principle and function to that described in the preceding paragraph, but a sensitive pressure control replaces the float operated transmitter and sends signals to a

motor driven multi-step controller which successively energizes and de-energizes the pump circuit thru the medium of mercoid switches. Separate pressure switches control the off and on operation of pumps from the levels in the wall and an additional high water alarm switch of similar type automatically cuts in the stand-by unit which in this case consists of the low and intermediate stage pumps. This equipment is not indicating, recording and totalizing, but simply control equipment.

Whenever there is a wide spread in the rate of flow, involving a pump control problem and consideration of initial and operating cost and economy, this control method is applicable. It requires no expensive electric controls, and results in efficiency and economy.

Time Study of Pump Operation Through Flow Range

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2 HP. Low Stage Pump; 375 G.P.M.; 540,000 G.P.D.

Inflow G.P.D.	G.P.M.	*Diff.* G.P.M.	*Rest Period Minutes*	*Running Time Minutes*
100,000	69	306	317	72
200,000	139	236	157	92
300,000	208	167	105	131
400,000	278	97	76	225
500,000	347	28	63	778
540,000	375	None	None	Continuous

5 HP. Intermediate Pump; 925 G.P.M.; 1,330,000 G.P.D.

500,000	347	578	63	38
600,000	416	509	53	43
700,000	477	448	46	49
800,000	557	368	39	59
900,000	624	301	35	72
1,000,000	694	231	32	94
1,100,000	764	161	29	135
1,200,000	834	91	26	239
1,330,000	925	None	None	Continuous

7½ HP. High Stage Pump; 1440 G.P.M. 2,075,000 G.P.D.

1,200,000	834	606	26	36
1,300,000	903	537	24	41
1,400,000	973	467	22	47
1,500,000	1042	398	21	55
1,600,000	1111	329	20	66
1,700,000	1180	260	18	84
1,800,000	1250	190	17	115
1,900,000	1320	120	16	181
2,000,000	1389	51	15	427
2,075,000	1440	None	None	Continuous

Workmen's Compensation Premiums on Sewer Department Employees Policies

A workmen's compensation policy covering a city's sewer construction force provided that the employer pay premiums on any operations incident to sewerage construction. The city divided its sewer department employees with a sewer construction force and a sewer maintenance and cleaning force. The Massachusetts Supreme Court held, Maryland Casualty Co. v. City of Taunton, 200 N. E. 775, that sewer maintenance was not incident to sewer construction so as to entitle the insurance company to an additional premium for employees engaged in sewer maintenance.

But the company was held entitled to an additional premium on a public liability policy covering the sewer construction force for employees engaged in sewer maintenance, the policy providing that it should be extended to any work at the city or vicinity not specifically eliminated from the coverage.

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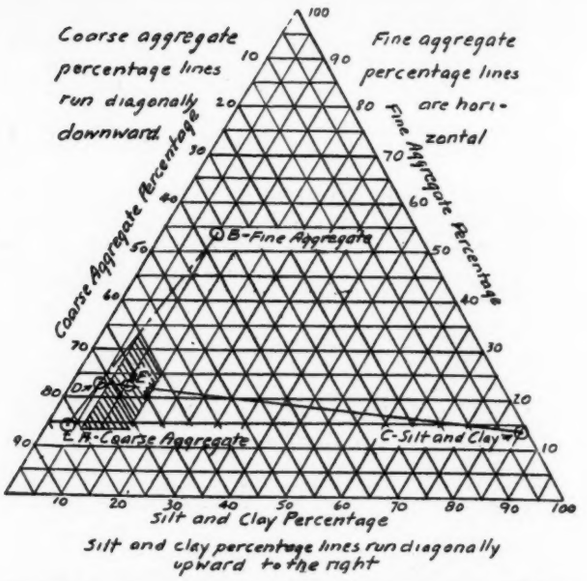
By ARTHUR R. SMITH
Engineer of Tests, Indiana State Highway Commission


Coarse aggregate percentage lines run diagonally downward
Fine aggregate percentage lines are horizontal
Coarse Aggregate Percentage
Fine Aggregate Percentage
B-Fine Aggregate
A-Coarse Aggregate
C-Silt and Clay
Silt and Clay Percentage
Silt and clay percentage lines run diagonally upward to the right

Triangular graph for determining stabilized mix. A, B and C are plotted points from example given in text. Shaded area shows limits of specified material.

AFTER several years' observation of the salt-stabilized road surfaces constructed in Indiana, we have come to the conclusion that this form of construction best fits our purpose as a base for a bituminous surface treatment or retread. Accordingly, all of our materials are designed to function most efficiently as a base course. For stabilized surfaces, rock larger than ¾ inch should be kept at a minimum, and slightly more soil binder than is used in base construction would also be quite desirable.

In the construction of a salt-stabilized road the same elementary steps used in all stabilized construction can be applied. They are as follows:

(1) A preliminary subgrade soil survey to locate the weak spots in the subgrade and to provide for the drainage or removal of unsatisfactory soil where necessary.
(2) The securing of the proper constituents for the stabilized mixture both from the standpoint of economy and quality.
(3) The design of the stabilized mix.
(4) The mixing of the materials and the incorporation of salt.
(5) The laying, wetting, shaping, and rolling of the stabilized mixture.
(6) The maintenance during and after the curing period.

A carefully made subgrade soil survey is especially valuable in stabilized construction, because the compaction obtained in the stabilized course when rolled with a truck or other type of roller, is directly dependent upon the support given by the subgrade below it. It is obvious that a weak subgrade offers little support against which to compact the loose layer of stabilized mix above it. The subgrade soil survey should determine the contributing sources of the weakness in the subgrade so that drainage or excavation may be provided where necessary and the weak spots corrected before any stabilized course is placed upon them.

It is advisable to sample possible sources of clay binder along the project during the survey so that a more thorough knowledge of the available clays may be obtained. In case a road mix is used, a knowledge of the subgrade soils is very essential.

Constituents of Stabilized Mixtures

There are usually three constituents required in the composition of stabilized mixtures.

(1) A well-graded, coarse aggregate. This may be pit run gravel, providing it is well-graded; crusher run limestone; or slag.
(2) A fine aggregate such as stone dust or sand, used to fill the large voids in the coarse stone, and containing sufficient material of minus 40-mesh size to give control of the plasticity of the finished mix.
(3) A binder having a plasticity index of between 12 and 25. When using an aggregate deficient in limerock particles a binder having a pH of less than 7 is not recommended. Acid soil binders can be used. however, if the mixture includes sufficient lime or limestone dust to neutralize the soil.

A careful screen analysis should be made of each material proposed for use in the stabilization and the plasticity of each should be determined. Of the three constituents the fine aggregate and the clay are interdependent. It is often the case that only one particular type of grading of fine aggregate or clay may be obtained. The other of these two must then be selected so as to work satisfactorily with the constituent which is available.

It is necessary that physical tests of the final mix show low capillary, or water-absorbing properties, otherwise, the clay binder will act as a lubricant during wet periods. This is true regardless of the chemical used. It is especially true of poorly-designed stabilized roads that are used as bases for bituminous surface treatments.

The mere fact that an untreated stabilized road is firm during wet periods is no assurance that it will remain so when covered with a bituminous treatment. It is, therefore, desirable that the mix be properly designed at the time of construction. The soil fines of the finished mix (material smaller than 40 mesh) should have a Liquid Limit under 25, a Plasticity Index of 9 or less (for base courses, 6 or less) and a Centrifuge Moisture Equivalent under 20.

Determining the Composition of Mix

There are several methods in use for the setting up of the stabilized mix. The trial and error method is thought by some to be the most satisfactory, but it is our experience, that the use of the triangular-graph method gives very satisfactory results, and eliminates the tedious process of assuming various values and actually mixing the constituents in these amounts, until the desired results are obtained. It is true that the success of the graph method depends upon accuracy in the sampling of the various constituents, but this also applies to the trial and error method. After the proportions have been established, a single trial mix will usually check within the desired limits.

*A paper before the 1937 meeting of American Road Builders' Association

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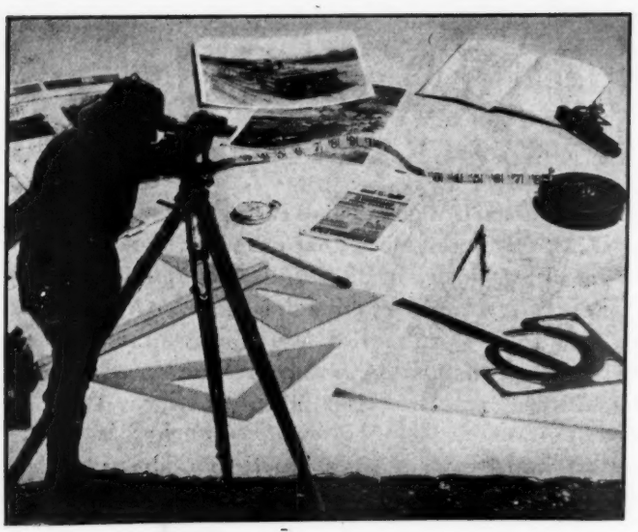

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The following example illustrates the use of the triangular-graph method.

In the use of this method all of the constituents are plotted on the graph according to the amounts of coarse aggregate, fine aggregate, and silt and clay they contain.

Coarse aggregate (CA) includes all material retained on the No. 10 sieve. Fine aggregate (FA) is that material passing the No. 10 sieve and retained on the No. 270 sieve. Silt and clay (S&C) is all material passing the No. 270 sieve. (The use of a No. 200 instead of a No. 270 sieve will not materially change the results.)

A typical calculation is as follows:

A test on the coarse aggregate, which in this case is crusher run limestone, shows it to have the following gradation:

Sieve	*Per Cent Retained*
1"	2
¾"	24
½"	52
#4	73
#10	82
#40	90
#270	96
P. I. of stone	0
Per cent of soil fines	10
Per cent coarse aggregate	82
Per cent of fine aggregate	14
Per cent silt (stone dust)	4

The fine aggregate used, agricultural limestone dust was graded as follows:

Sieve Size	*Per Cent Retained*
#10	36
#40	72
#270	89
Plasticity index	0
Per cent coarse aggregate	36
Per cent fine aggregate	53
Per cent silt (limestone dust)	11
Per cent soil fines	28

Tests on the soil binder which was a silty clay having a pH value of 4.5 (after mixing with the aggregate the pH value was above 7) were as follows:

Sieve Size	*Per Cent Retained*
#10	1
#40	3
#270	15
Plasticity index	13.3
Per cent coarse aggregate	1
Per cent fine aggregate	14
Per cent silt and clay	85
Per cent soil fines	97

Computations.—Plotting the coarse aggregate (A), fine aggregate (B), and binder (C) on the triangular chart, draw the line AB. Any point on this line represents a combination of the two aggregates. In the same manner any point on a line joining the line AB and the point C represents a combination of C and of A and B in proportions determined by the point of intersection with the line AB.

A recommended gradation for base construction is given. For surfaces the top size should be reduced to ¾" or as desired and the fines may be increased slightly.

Passing Sieve	*Limits per cent Retained*
1½"	0
1"	0-15
¾"	5-35
½"	20-70
#4	40-75
#10	60-80
#40	70-85
#270	85-93

The gradation limits of the coarse aggregate, fine aggregate and silt and clay of the specification are plotted on the triangular chart, with coarse aggregate 60-80; fine aggregate 13-33 and silt 7 to 15.

Draw the line CD so that it falls well between the upper and lower limits of the specification band. Now that D is definitely located—*DA/AB $= \frac{2.9}{13.5} = 21.5\%$ of the per cent of fine aggregate in the combination of coarse and fine aggregate. DA and AB can be scaled or computed.

$\frac{10.6}{13.5} = 78.5\%$ of the per cent of coarse stone in this combination.

Choosing the point E well within the specification band. The two segments DE and EC respectively represent the amounts of clay and the combined coarse and fine aggregate that make up the finished mix. Thus: $DE/CD = \frac{1.45}{23.7} = 6.1$—the per cent of clay the finished mix, and: $EC/CD = \frac{22.25}{23.7} = 93.9$—the per cent of the combination of coarse and fine aggregate in the finished mix. To convert this to actual percentages of coarse and fine aggregate it is necessary to multiply the fractions that go to make up the combination by the percentage of the combination in the finished mix.

Therefore: $93.9 \times 21.5 = 20.3$—the percentage of fine aggregate in the mix.

$93.9 \times 78.5 = 73.6$—the percentage of coarse aggregate in the mix.

Thus the composition of the finished mix represented by the point E is:

20.3	per cent fine aggregate
73.6	per cent coarse aggregate
6.1	per cent clay
100.0	

When the separate materials previously given are combined in the above proportions the grading of the mixture is as follows:

Sieve Size	*Stone Fraction*	*Fine Aggregate Fraction*	*Binder Fraction*	*Total pct. Retained*
1½	0=			0.
1"	2×.736=1			1.
¾"	24×.736=17.6			17.6
½"	52×.736=38.2			38.2
#4	73×.736=53.7	0×.203=0		53.7
#10	82×.736=60.4	36×.203= 7.2	1×.061=0	67.6
#40	90×.736=66.1	72×.203=14.6	5×.061=0	80.7
#270	96×.736=70.6	89×.203=18.1	15×.061=1	89.7

Per cent passing the 270 sieve, 10.3

It is very desirable to check the plasticity index of the finished mix in order that the material does not have detrimental water-absorbing properties. An approximation of the plasticity index of a stabilized mixture composed of materials having widely different characteristics can be computed by means of the following formula:

Let X—% of sample "A" in mix
Y—% of sample "B" in mix
Z—% of sample "C" in mix
S_1—% of soil fines in sample "A"
S_2—% of soil fines in sample "B"
S_3—% of soil fines in sample "C"
P_1—plasticity index of soil fines in sample "A"
P_2—plasticity index of soil fines in sample "B"
P_3—plasticity index of soil fines in sample "C"
P —plasticity index of soil fines in finished mix.

Then: $$P = \frac{(XS_1P_1 \,\&\, (YS_2P_2) \,\&\, (ZS_3P_3)}{(XS_1) \,\&\, (YS_2) \,\&\, (ZS_3)}$$

For calculating purposes, when P_1P_2 or P_3 equals zero, the figure 1 is used in the fromula.

Working out the previous example, we have:

$$P = \frac{(73.6x10x1) \,\&\, (20.3x28x1) \,\&\, (6.1x97x13.3)}{(73.6x10) \,\&\, (20.3x28) \,\&\, (6.1x97)} = 4.9$$

This P.I. is suitable for a base and also for a surface. A trial mixture should be made up in order to actually determine the liquid limit, the plastic limit and thereby the plasticity index. The P.I. is computed by the following formula: P.I. = Liquid Limit — Plastic Limit.†

The particular example illustrated above has but a small percentage of soil binder. Limestone dust was used as a fine aggregate, which in itself has cementing properties. If gravel is used as an aggregate, it is likely

*NOTE: The segment DA representing the sand is taken farthest away from point B. The same is true of the other representative segments.

† See—American Association of State Highway Officials Standard Specification for Highway Materials for methods of soil testing.

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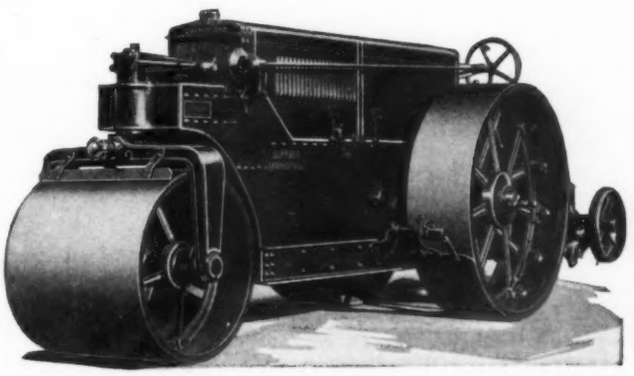

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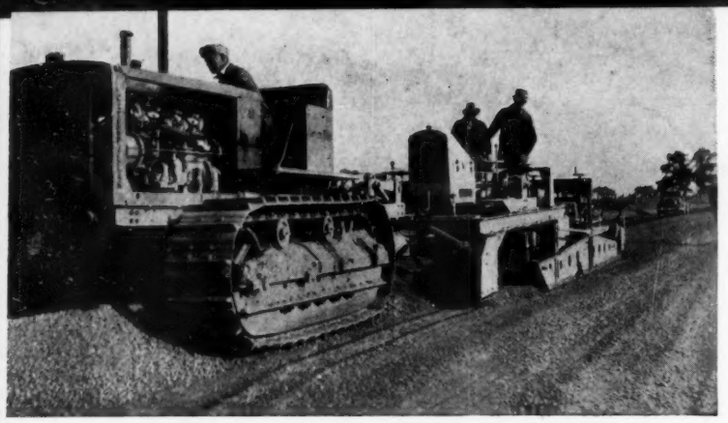


The Jaeger Triple Pug Mill Road Builder mixes and lays ready for sprinkling and rolling at rate of one mile per hour if necessary.

that more soil binder would be used. However, the amount will depend upon the tests of the material at hand.

Mixing the Materials

Road mixing of clay and aggregate still remains the most common method of mixing stabilized material. The method used by John H. Barr of Oakland County, Michigan, seems to be one of the most workable suggested for road mixing.

It has been found convenient to work each project in half-mile sections, and the method used is as follows:

1. All loose material on the roadway is windrowed to the center.
2. Enough new material is added to the windrow to bring the total quantity to approximately 1,000 cubic yards per mile. This is done by measuring the windrows. This quantity, when stabilized, will produce a wearing course 3 inches deep and 20 feet wide.
3. Soil binder is then delivered and windrowed on each shoulder in sufficient quantities to produce a stabilized mix of the desired plastic index: the quantity having previously been determined by test in the laboratory.
4. As soon as the soil binder has become dry, it is spread, pulverized, and bladed back into its original position on the shoulders.
5. The gravel windrow from the center is then spread over the prepared subbase between the rows of soil binder and the pulverized soil binder is then spread uniformly over the gravel.
6. The mass is then thoroughly mixed by blading and, after mixing, it is split into windrows on each shoulder of the road.

The material is then brought into the roadway, leveled, moistened and compacted.

All future Indiana work contemplates the use of a plant mix of some description. We have not specified any particular type of mixer as yet, preferring to leave this to the ingenuity of the contractors. Inasmuch as we use pulverized friable clays of low plasticity as soil binders, the mixing unit need not be particularly thorough. On several of our roads the materials were mixed in a concrete mixer. Mixing can be done either wet or dry. When mixed wet in this type mixer, it is necessary that the mass contain a large portion of aggregate and a small portion of soil binder. Otherwise, the material is liable to clog the mixer. We have also had satisfactory results when the pulverized soil binder has been added to the production line of an aggregate plant. The mixing is done over the various screens in the plant and when a small amount of moisture is present the material comes out quite well mixed. We have laid more stress on the proper proportioning than we have on the mixing. Several manufacturers have recently developed pugmill mixers of the continuous type designed specifically for stabilized work. While we have not had any first-hand experience with this type unit, we have had reports indicating that it is very satisfactory. The State of Onio has used a traveling road mixer of the triple pugmill type. It is our understanding that this mixer also works well with stabilized material.

Incorporation of Sodium Chloride

Salt can be added to the stabilized mixture either in the crystal form or as a brine. Both methods have been used and both are satisfactory. We prefer in our own work to use a brine as we feel that the chemical is more thoroughly distributed throughout the mix. On several 1937 contracts it is the intent to require a portion of the brine to be added to the materials when they are plant mixed. The addition of moisture at the time of mixing materially reduces segregation.

There have been various amounts of salt used in stabilized work by the various states; the most common amount seems to be two pounds per square yard for 3 inch depth. On our 1937 work we contemplate using 2½ pounds per square yard, throughout a six inch thickness.

Placing and Compacting

There have been many improvements in the methods of compacting stabilized roads. In some cases traffic is the only means of rolling. On base construction where it is necessary that the mat be compacted in as little time as possible different methods must be used. By placing three to four inches of loose material and using dual-wheeled trucks or multiple-wheeled rollers very good compaction can be obtained. We have just recently tried the use of the tamping roller on gravel stabilized base. To date all tests have shown satisfactory results.

Since moisture or brine is essential for good compaction the method used will depend directly upon the ease with which water can be incorporated in the mixture. If the design is such that water will not penetrate readily then it is necessary to place thin layers. We have found it possible to moisten satisfactorily 8½ inches of loose stabilized gravel with a surface application of moisture when the percentage of soil fines (material finer than 40 mesh) is approximately eighteen. In this case the tamping roller combined with a ten ton three-wheeled roller compacted the material to 5 inches.

A study of the effect of moisture upon the degrees of compaction obtained will be helpful to the engineer. We find that our mixes compact most readily at approximately 8% (by weight) moisture. By using Proctor's method of investigating soil compaction, the exact percentage of moisture for any mix can be determined.

Maintenance Cost Data from Rhode Island

For a number of years this magazine has published maintenance cost data covering Rhode Island state highways. The following figures, covering 1935, have just been furnished us:

Type of Surface	Miles	Sq. Yds.	Cost	Cost Per Sq. Yd.
Bituminous Concrete (Coarse Aggregate)	16.117	169,535	$10,820.54	$0.0638
Bituminous Concrete (Graded Aggregate)	64.920	740,270	3,816.21	0.0051
Bituminous Macadam (Penetration)	254.850	3,120,148	5,420.33	0.0017
Bituminous Surface on Concrete Base	29.093	621,045	1,256.54	0.0020
Cement Concrete	164.874	2,503,356	14,739.47	0.0058
Bituminous Surface on Crushed Stone Base	1.272	21,616	77.19	0.0035
Totals for State — All Classes	531.126	7,175,970	$36,130.28	$0.0050

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

The Digestion Tank

Trickling filters in some New York state institutions have developed snails in large quantities. At Rockland hospital last July the top of the stone was covered with millions of them. At Rome State School snails appeared in one corner of a bed and spread until, several months later, practically the entire area was covered. They have eliminated previous trouble from pooling and the effluent, as indicated by the methylene blue test, has materially improved. The snails may not deserve the credit for this, but at least they have done no harm.[C24]

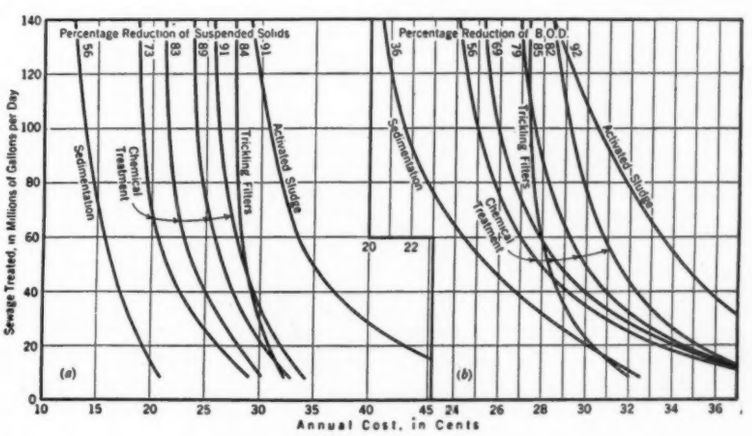
Aeration systems using air diffusion, paddle wheel and Simplex surface aeration, tested at the Davyhulme (England) plant, indicated that, producing an effluent of from 15 to 20 ppm. B.O.D., the bio-aeration system required from 15 to 18 hours aeration, the Simplex from 8 to 13, and the direct air (without reaeration) from 6 to 9 hours. Attention is called to the long channels for bio-aeration (354 ft.), which at other places are materially shorter, producing better results.[H41]

Seeding digestion tanks at Geneva, N. Y., prior to putting into service in October, resulted in the production of gas within a few hours. There are two circular tanks 45 ft. diameter and 21 ft. side depth. At the start of operations, 60,000 gallons (23% of its capacity) of digested sludge was placed in one tank, being transported by tank truck from the Newark, N. Y., sewage plant. Fresh solids and sewage then were pumped to the tank until it was filled and sufficient lime added to maintain a pH of 7.2. The water seal of the gas dome was closed and the stirring mechanism started, and gassification began soon after. The second tank was similarly seeded from the first.[C23]

Economics of sewage treatment were analysed by the author on the basis of cost and operating data of plants in all parts of the country; the former on the basis of total annual charges per mg. of sewage treated per 1% reduction in either suspended solids or BOD. He does not consider increase of cost with degree of treatment or plant size. The results are shown in the accompanying diagram. Screens and grit chambers make for efficient and economical operation of the rest of the plant, especially if the sewage is from a combined system. With screens with 1″ clear openings and effective grit chambers, removal of 7 cu. ft. per mg. may be expected. For average sewage, the economical sedimentation period is 3 to 3½ hrs. on the basis of BOD reduction, or 1¼ to 1½ hrs. on the basis of reduction in suspended solids; the former only where there is no secondary treatment. For activated sludge, the most economical period of aeration is about 4½ hrs.. of sedimentation is ½ hr. Reductions by magnetite sand and modified rapid sand filters are a function of the strength of filter effluent and type of basic treatment.[L4]

New developments in sewage treatment cannot use Illinois municipalities as proving grounds. The Illinois Sanitary Water Board has adopted the policy that "any new development must have been thoroughly tested to the satisfaction of the Board in a full-scale installation under competent supervision before a permit for a plant, including this process or equipment, would be issued, unless the municipality was amply protected so that in case of failure any expenditure of public money would be refunded. . . . While the effluent from the proposed new process is of primary consideration, operation costs are also of interest to the extent that they be sufficiently low to permit the treament works to be operated at reasonable cost and within the financial ability of the municipality. Such a policy has not discouraged the installation of new types of equipment and treatment processes. On the contrary, many progressive developments in sewage treatment methods have resulted from the pioneering work in Illinois."[H38]

Surge in a sewer may occur on the suction side of a pumping plant, sufficient in some cases to back up into houses or streets. In a small plant a suction well may adequately serve as a surge chamber, but the well in a large system may be too small relative to the flow to meet the requirements. In the Detroit system now under construction an intercepting sewer 50,000 ft. long and 9 ft. to 16 ft. diameter, leading to a pumping plant, will carry 251,000 tons of sewage travelling at 5.1 to 7.28 ft. per sec., giving a kinetic energy of 294,000,000 ft. lb. To dissipate this energy with a 16 ft. surge tank, it would need to be 217 ft. high. Three solutions were considered—spill the surge over a weir at the plant into a 16 ft. conduit leading 1,380 ft. to the river; spill it into a basin constructed adjacent to the pumps; and spill it into the river (only 50 ft. away) at a point 3,000 from the pumping station. The first presented operating difficulties. The second would require a basin 158 ft. square by 11.5 ft. deep. The distant weir could not relieve all



Civil Engineering

Total annual charges of various methods of treatment per million gallons of sewage treated per 1% reduction in (a) suspended solids and (b) 5-day B.O.D.

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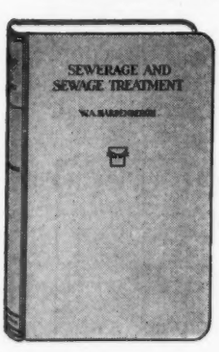
SEWERAGE AND SEWAGE TREATMENT

By W. A. HARDENBERGH



All who are looking for an authoritative yet simple treatment of this subject will appreciate this new text. The author's editorial and field work have brought him in close contact with the problems which trouble the average engineer, and in this book he outlines those methods most suitable for handling the work. Particular attention is paid to designing sewerage systems, both storm and sanitary.

PARTIAL TABLE OF CONTENTS:

Hydraulics of Sewers
Design of Sanitary Sewers
Design of Storm and Combined Sewers
Grit Removal and Screening
Sedimentation
Chemical Treatment of Sewage
Activated Sludge Treatment
Secondary Treatment of Sewage
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the surge. A combination of the two latter was adopted, by which the basin could be reduced to 69 ft. square by 11.5 ft. deep, the distant weir being 83.5 ft. long.[L6]

Institutional sewage has several peculiar features, at least in New York state. For 18 institutions the average per capita flow is 170 gpd.; the lowest (a prison) 100 gpd. and the highest (an insane hospital) 295; with peak rates 3 times these averages; total solids 400 to 700 ppm. Therefore all pumps and other units must have a greater per capita capacity than for municipal plants. Temperatures average 75° F., which is beneficial, especially in winter, except that it renders grease traps inoperative; in one institution it congeals on walls of pump well and breaks off in lumps that clog the 4" centrifugal pump. Grease is more abundant than in city sewage, requiring more skimming of clarifiers and attention to gas vents; forms scum instead of sludge. This sewage contains more rags, towels, etc. (the insane delight in tearing up sheets and putting them in the toilets), which cause clogging of machines, even of mechanical screen cleaners.[C24]

Bibliography of Recent Sewerage Literature

c, Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

D *The Surveyor*
February 19
18. Sewage Disposal in India. By F. C. Temple, p. 310.
February 26
19. Sewage Disposal in Europe, pp. 341-342.
20. *p.* Chemical Methods of Treating Sewage. By J. H. Garner, H. H. Hendon and K. Imhoff, pp. 343-347.
March 5
21. *p.* Chemical Treatment of Sewage. By J. Nixon, pp. 385-386.

E *Engineering News-Record*
February 25
7. Extension of Sewage Disposal Facilities for Boston Area, pp. 292-293.
March 11
8. Large Sewer on Ocean Bottom Has Joints of Novel Design, pp. 369-373.
March 18
9. Practical Soil Mechanics for Small Dams. By D. Doggett, pp. 409-412.

G *Water Works and Sewerage*
March
10. Sewerage and Sewage Treatment in Review. By C. G. Hyde, pp. 71-80.
11. *p.* The Newer Methods of Sewage Works Financing. By C. W. Klassen and W. H. Wisely, pp. 88-93.
12. Some Laboratory Kinks and Time Savers. By C. A. Habermehl, pp. 96-98.
13. Flow Study on a Separate Sanitary Sewer System. By V. W. Willits, p. 107.

H *Municipal Sanitation*
March
38. St. Charles (Ill.) Sewage Treatment Plant. By C. W. Klassen, pp. 172-175.
39. Report on Chicago's Amebic Dysentery Epidemic, p. 175.
40. Triturator Performance at Milwaukee. By W. B. Marshall and R. C. Merz, pp. 176-178.
41. Sewage Treatment Abroad. By W. Rudolfs, pp. 179-183.
42. Waste Disposal for Greenbelt, Md. By F. Schmitt, pp. 186-187.
43. Garbage-Fed Hogs Held Responsible for Trichenosis, p. 187.
44. Laboratory Control of Sewage Treatment: Bacteriology. By F. W. Gilcreas, pp. 188-189.
45. Sewage and Industrial Wastes Disposal: In Indiana, by B. A. Poole. In West Virginia, by E. S. Tisdale, pp. 190-192.

J *American City*
March
6. New Sewage Treatment Plant Built to Be Attractive. (Bloomington, Ind.) By C. B. Carpenter, pp. 60-62.
7. Combined Wastes Disposal Plant at Herkimer, N. Y., pp. 63-66.

L *Civil Engineering*
March
3. *p.* Sewage Treatment at Cleveland. By G. B. Gascoigne, pp. 200-202.
4. *p.* Economics of Sewage Treatment. By G. J. Schroepfer, pp. 202-203.
5. *p.* Deoxygenation and Reoxygenation. By C. J. Velz, pp. 203-204.
6. Surge in Water and Sewer Tunnels. By A. B. Morrill, pp. 205-208.
7. Sewer Maintenance on Engineering Problems. By R. R. Ribal, pp. 209-212.

P *Public Works*
March
15. Trenching for Sewer Construction, pp. 14-16.
16. Equalizing Flow to Treatment Plant from Intermittent Pumping. By M. N. Hammon, Jr., pp. 27-28.

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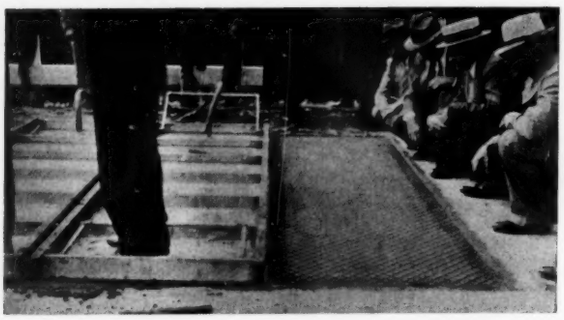
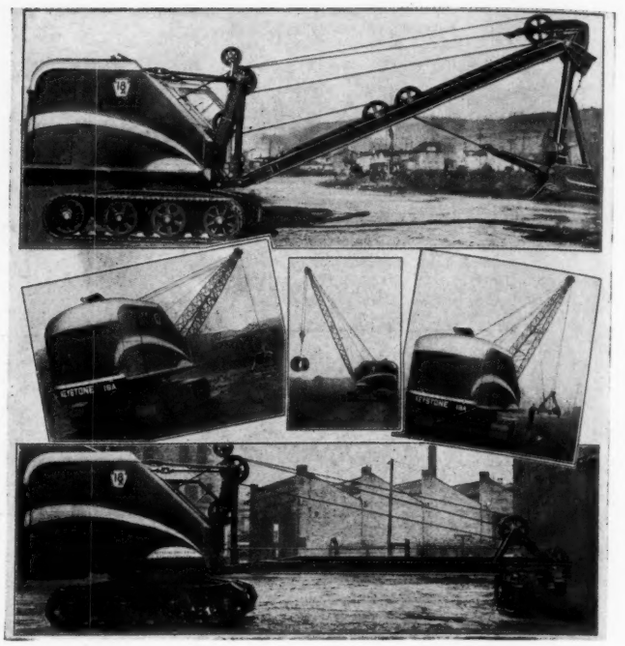


Vacuum Concrete

Vacuum concrete is concrete with a water content not exceeding 3 gallons per bag of cement; hard before hydration, because of compression; with shrinkage eliminated; with strength, early and ultimate, increased from 30% to 100%; and absorption materially decreased.

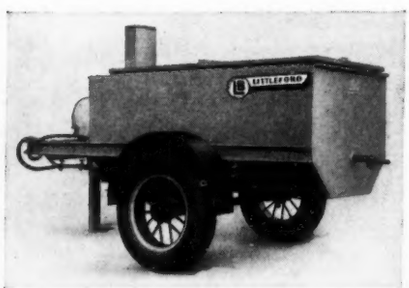
The Vacuum Concrete Corp., 30 Rockefeller Plaza, New York, has an interesting folder on this subject, containing much information. The accompanying illustration, taken from the folder, shows a 2-inch non-skid vacuum concrete resurface being placed on the Putnam Pike, near Providence, R. I.



Above, placing vacuum concrete near Providence, R. I. Right, the Keystone excavator performs a variety of duties.

New Littleford Tar and Asphalt Kettle

Littleford Bros., Cincinnati, O., have announced a new style tar and asphalt heating kettle. It is built along the lines of the Littleford 84-HD, with double



The Littleford Heater

heat circulation and a screened reservoir. It is rated at 300 gallons, but is stated to have an actual capacity of 350 gallons.

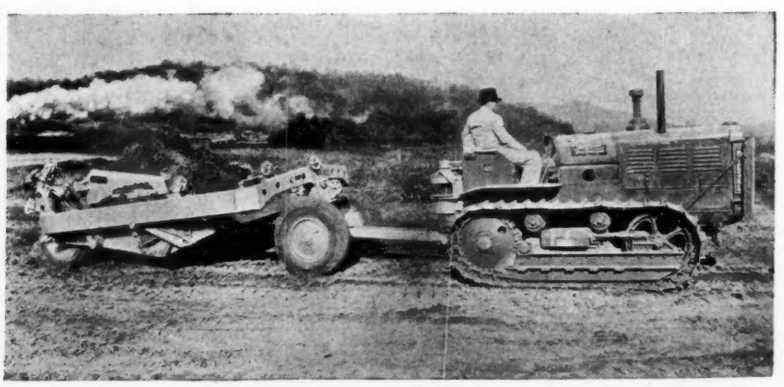
The actual weight is 2,250 pounds, on pneumatic tires, which is desirable when it is intended to use light trucks for hauling. The loading height above ground is 59 ins., and the overall dimensions are 135 by 70 inches. Full information on request.

Keystone 1-Yd. Excavator

The Keystone 18-A 1-yd. excavator is built for a variety of digging, having one boom that is used in both trench hoe and skimmer service and to which a short extension may be attached for short boom, crane service. The machine is also available with a boom for dragline, clamshell and crane.

By means of the oversize clutches and planetary drives for both boom swing and line movement, it is possible to ease loads into position with great precision. Loads may be picked up as gradually or as quickly as desired and moved at the speed most practical for each kind of job. In close quarters the accuracy of control and short tail swing facilitate many operations.

Model 18A is powered by Buda Engines, either gasoline or Diesel; or, if desired, by any standard make electric motor.



Bucyrus-Erie Co., So. Milwaukee, Wisc., have announced a 4-wheel scraper, which is furnished in two sizes—4½ and 7 yds. level measure. In spreading the scraper blade levels off the dump. Turns in its own length. Detailed and well-illustrated bulletin on request.

Left, Easton Car & Construction Co., Easton, Pa., has developed a streamline dump body for quarry and highway work. Capacity 7 yds. level, 9 yds. heaped. Body's unusual shape results in high ratio of loading capacity and correct load distribution

Right, Ransome Concrete Machinery Co., Dunellen, N. J., have brought out a truck mixer and agitator. Furnished in capacities as follows: Truck mixer, 1 to 5 cu. yds.; agitator, 1½ to 7½ cu. yds. Information on request.

Announcing A New 300-Gallon Kettle

This No. 84-HD6 fills a need felt by many maintenance departments for an economical heater that will heat large quantities of any type of bitumen quickly. A kettle that is made along modern lines—that is not too heavy, yet built to stand years of hard use on all kinds of work.

The actual capacity of this unit is approximately 350 gallons. It has Littleford "double heat circulation" and the same inverted V type screen in the reservoir that has proven so successful in other sized models of the favorite Littleford No. 84-HD Heater.

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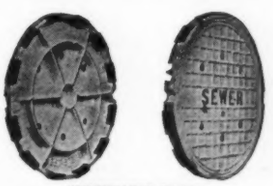

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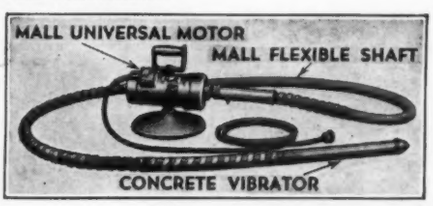

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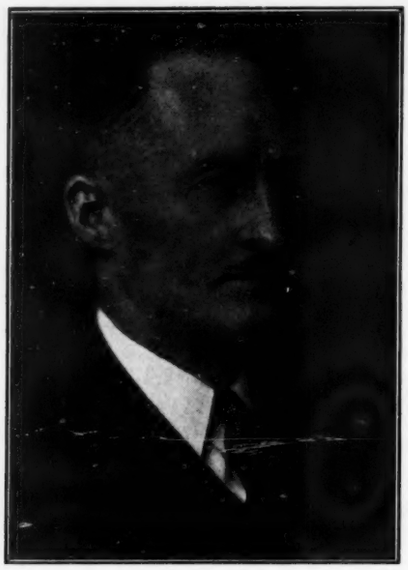

Kenneth F. Park

Kenneth F. Park is manager of a newly organized promotional engineering department of R. G. Le Tourneau, Inc. This department, through visits of its staff to earthmoving projects throughout the United States, will accumulate and maintain for the benefit of contractors and others a constantly current fund of data on the best construction practices. The services of its engineers are available on request for estimating earthmoving on proposed projects.

Promoted from assistant eastern sales manager, Mr. Park, an associate member of the American Society of Civil Engineers, is well equipped for his new duties. He chiefly is responsible for the Le Tourneau time studies, job action photographs and project data that have been invaluable to contractors and distributors in the preparation of estimates during the past eight years.

News of Engineers

Fred Stuart of Activated Alum Corp. is taking his traveling laboratory to Florida for the short school for water works operators being given by the University of Florida in co-operation with the Florida State Board of Health.

W. F. Perkins has been placed in charge by the Koppers Co., of that company's Western Gas Division at Fort Wayne, Ind., which produces valves, hydrants, cast iron and steel pipe, and other water and public works equipment.

E. R. Galvin has been appointed general sales manager of the Caterpillar Tractor Co.

Clarence Dykstra, city manager of Cincinnati, O., has been elected president of the University of Wisconsin, Madison.

Merrill Bernard has been appointed chief of the River and Flood Division of the U. S. Weather Bureau, to fill the vacancy caused by the death, last fall, of M. W. Hayes.

American Water Works Association

The program of the American Water Works Association annual convention at Buffalo, N. Y., June 7-11, 1937, is to include a complete presentation and discussion of the work that is being done on the preparation of a Manual of Water Works Accounting Practice.

This project is being carried on jointly by the American Water Works Association and the Municipal Finance Officers' Association. It has as its object the preparation of a practical manual of water works accounting procedure, designed to be adaptable to the use of both publicly and privately owned plants in cities from 100,000 population down to 5,000 population.

The original draft of the proposed manual is being made under the direction of Charles T. Sweeney, C.P.A. of Springfield, Ohio, the work being financed by the Spellman Fund, through the Municipal Finance Officers' Association. As prepared, each section of the draft is submitted to the members of the Review and Recommendations Committee and then passed upon by the Final Approval Committee, both of which committees are made up of members of the American Water Works Association selected for their experience and diversity of viewpoint on such matters.

At the convention at Buffalo, Carl H. Chatters, Director of the Municipal Finance Officers' Association, and Mr. Sweeney will both speak on the subject of the Manual and a general Round Table discussion will follow under the leadership of Mr. Hal F. Smith of Detroit, chairman of the A. W. W. A. Finance and Accounting Division, and the other officers of that Division.

A comprehensive review of the recent Ohio River flood conditions, and of the lessons learned and work to be done as a result of them, is also to form an important feature of the program.

Not only will speakers describe the actual flood experiences with their water works by means of illustrated talks, but the session will also devote much time to a presentation and discussion of the many lessons to be drawn from these experiences.

The session on the Ohio River floods is to be followed by another discussion dealing with the organization and planning of water works for major catastrophes in general, including floods, conflagrations and earthquakes.

Laboratory Equipment:

Bulletin 300—Condensed catalog on "Precision"—Freas Constant Temperature Laboratory Equipment, Precision Scientific Company, 1730-1732 N. Springfield Avenue, Chicago, Ill.; 8-page, 2-color bulletin. Pictures and concisely describes all Freas and Thelco models of incubators, sterilizers, humidity cabinets, pointing out their respective applications and individual characteristics.

Ben Tippins Joins Activated Alum Corporation:

Ben F. Tippins, formerly superintendent of water works and sewage disposal at Daytona Beach, Florida, has been made plant superintendent of the new Activated Alum Plant at Curtis Bay, Baltimore, Maryland. Mr. Tippins has a long record of service in water treatment, having been superintendent of the Daytona Beach, Florida, softening plants for 17 years—operating three separate plants, each of a different type.

Of interest to the water works profession in general, it was Mr. Tippins who first used powdered activated carbon in pre-treatment at a softening plant

Ben Tippins

for odor control. The results of this early work in 1931, which resulted in the practice of adding carbon to the coagulated water, thus sweetening the sludge and filter sand, was dubbed "Stabilization of Sludge," which practice is now in general use. From these experiments came black alum, which Tippins also first introduced.

Activated Alum's new plant will be placed in production April 15, manufacturing not only Activated Alum (Black Alum) but ferric sulphate of alumina, Coag, regular commercial sulphate of alumina and highly refined alum for the pulp and paper trades.

A. P. Armington Dies

A. P. Armington, president of The Euclid Road Machinery Company, Cleveland, Ohio, died suddenly March 18 aboard the steamship President Adams while crossing the Pacific Ocean on a world cruise.

New Littleford Representatives

The Hall-Perry Machinery Co., Butte, Mont., has been appointed exclusive Littleford agents in the State of Montana. The Jeff Hunt Road Machinery Co., Columbia, S. C., represents Littleford in South Carolina. The Southern Iron & Equipment Co., Atlanta, Ga., have been appointed Littleford dealer in Georgia.

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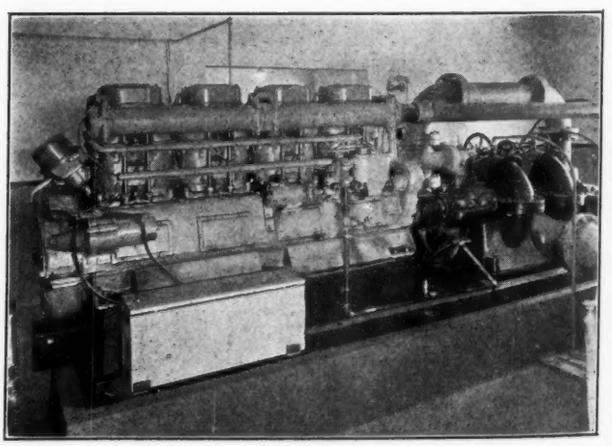

A Sterling Dolphin C-8 cylinder 240 H.P. engine direct connected to an 8" 2 stage Babcock, Wilcox & Goldie McCullough centrifugal pump. This unit provides power in emergency at Kirkland Lake, Ontario, and is the third Sterling purchased by this enterprising town.

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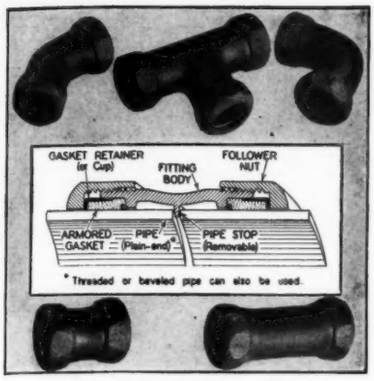
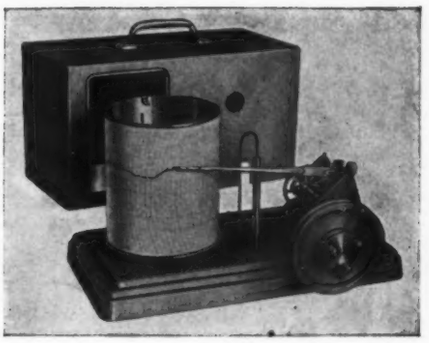
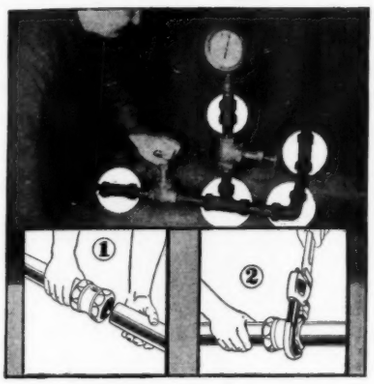


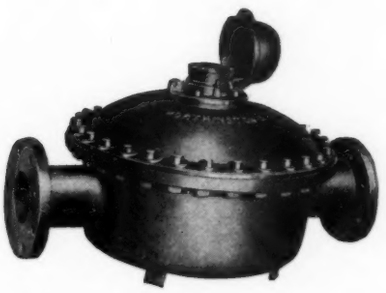
New Small Dresser Couplings

At left are shown the new Dresser "65" fittings, which require plain end pipe only for a tight joint—no cutting of threads is required. The top sketch shows the working principle of this new joint which is made for all pipe sizes from ⅜-in. to 2-inch. Full information from S. R. Dresser Mfg. Co., Bradford, Pa. Catalog on request



This is the new Friez model FW portable water level recorder. These are especially suited to ground water studies as small diameter floats can be used without loss of accuracy (6-inch or 3-inch). The recorder is only 6 x 8 x 12 inches and weighs 10½ pounds. Time scale for one revolution of chart—6 to 192 hours. The illustration shows model FW-1, on which the chart is of the curvilinear coordinate type. Carrying cover is shown in background. Full information from Julien P. Friez & Sons, Inc., Baltimore, Md.





Worthington heavy duty disc type water meters, in 3-in. and 4-in. sizes, are described in Bulletin M-975-B34. Sent on request to Worthington, Harrison, N. J.

The portable pH meter shown is entirely independent of color, turbidity or suspended matter in solution direct pH reading, over a wide range. Thwing Instrument Co., Philadelphia, Pa.

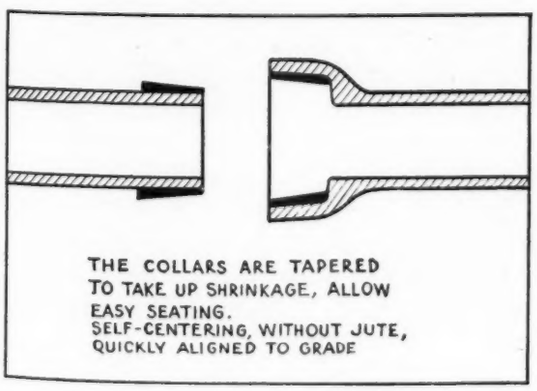
Slipseal Joints for Clay and Concrete Sewers

The illustrations herewith show the essentials of constructing tight joints in clay and concrete sewers by a new method. A steel die is placed in the bell end of the pipe, and the annular space around it is poured with a special compound. A ring permits the same treatment for the spigot end. Thus the joints are poured completely on the ground surface.

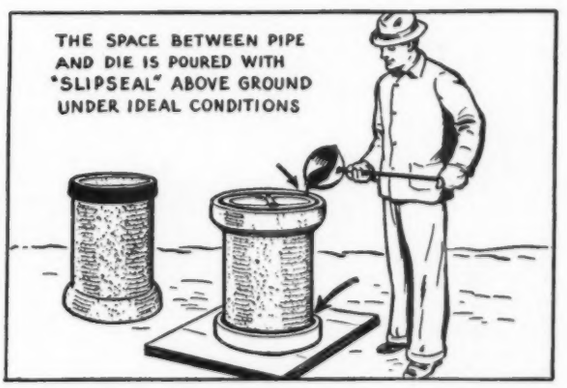
The joint is completed by painting, shortly before the pipe is to be laid, these collars with a solvent which softens and makes gummy the surfaces. The collars are slightly tapered, which facilitates centering and insures a tight joint. The solvent soon diffuses, and the joint becomes an integrated whole.

The pouring of the collars can precede the laying of the pipe by almost any desired length of time, so that laying need not be delayed. Backfilling can proceed as soon as the pipe has been fully entered. The resulting joint is said to be acid, root and infiltration proof and to be usable even under a head.

This joint is furnished by the Universal Sewer Pipe Corp. and the American Vitrified Products Co., Union Trust Building, Cleveland, O. Folder on request.



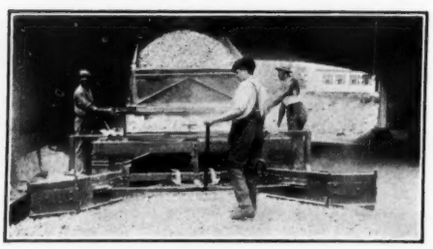
These illustrations show how to make Slipseal joints.



Foote Finish Spreader

The Foote Co., Inc., of Nunda, N. Y., have announced the Adnun "finish spreader" which is designed to handle and spread all types of road stone, slag, gravel, and cinders. Its use is said to eliminate the need for a grader, and to avoid waste of materials and over-run.

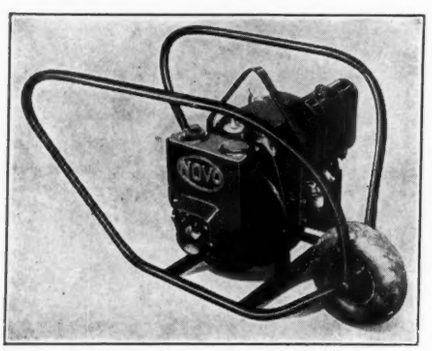
There is no engine and few moving parts; maintenance costs are low. Accuracy is assured by long guide rails which span small irregularities that may be present in the subgrade. It will shape any crown or bank, and the crown or bank contour can be changed while in motion. The spreading width is variable and easily adjusted up to 11 feet and material can be laid right to the curb.



The Foote Finish Spreader

A Full Streamline Pump

The Novo Engine Company of Lansing, Michigan, have just announced a new portable 2″ self-priming centrifugal pump, with a Novo streamline, 2 HP, air cooled engine and equipped with handles that form a double protection for the pump besides giving easy portability. The pump is thus protected in the event of rough handling or up-setting in moving the suction hose. A doughnut air wheel is standard equipment. Although the pump is classified as a 5M Pump under the AGC rating, it has a capacity of better than 6,000 GPH at a 10′ head and better than 4,100 GPH at a 25′ head. The weight of this pump is only 145# net on skids.



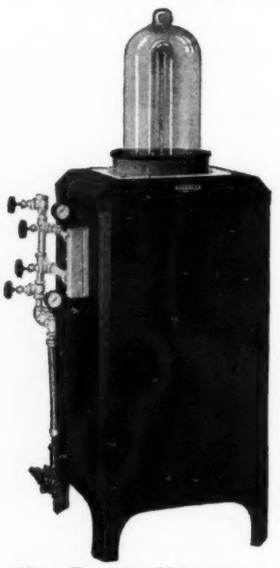
The Novo Streamline Pump

A Portable Traffic Light

Lewis Mfg. Co., Decatur, Ill., has developed this especially for use with schools. A permanent base and connection is placed in the street. Carries green, amber and red lights. Can be used when children are going to and coming from school. Easily removed when not in use. Full details on request.

Everson Rota-Meter Chlorinator

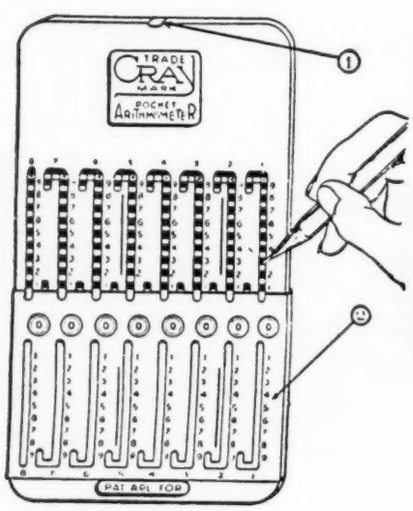
Everson Manufacturing Company, Chicago, Ill., announce a new line of Everson Rota-Meter Chlorinators with capacities of one half of one pound to one thousand pounds of chlorine gas per 24 hours. The "Rota-Meter" consists of a silver rotor supported by a column of gas in a tapered calibrated tube. Shaped like a tiny top, the rotor spins by means of flutes or fins suspended in the calibrated tube, its position on the scale indicating the flow. It is said to be accurate within 1%.



New Everson Chlorinator

Safety features include, a double glass case and water sealed bell jar over the "Rota-Meter," automatic venting devices, automatic vacuum break and non-corrosive valves lines and fittings.

These chlorinators come in two styles —the skeleton and enclosed type. Each model has a ratio of one to ten between its maximum and minimum capacities. The DeLuxe Model is illustrated.



Left, the Arithometer made by Tavella, 25 W. Broadway, N. Y. Fine for calculating. Especially recommended for Timewaster fans (p. 7)

Right, the Chain Belt Triturator, which shreds and cuts up sewage screenings. Capacities 15 to 60 cu. ft. per hr., requiring 3 to 10 hp. Small amount of water required. Shredded material is of such fineness that it remains in suspension in the sewage. Chain Belt Co., Milwaukee, Wisc.

Readers' Service Department

CONTINUED FROM PAGE 60

These booklets are FREE to readers of PUBLIC WORKS.

Cast Iron Sewers

385. For use in wet ground to prevent infiltration, for crossing under railways and heavy duty highways, and for all other sewer construction where replacement, repairs or reconstruction would be costly, cast iron pipe is most economical. For details, specifications, etc., write Thomas F. Wolfe, Cast Iron Pipe Research Ass'n, 1013 Peoples Gas Bldg., Chicago, Ill.

Couplings for Pipe

386. This sixteen-page booklet is a reprint of a magazine article by a consulting engineer. It describes in detail the installation of a 42" water line; contains specific information regarding pipe joints, field organization, laying pipe, tests, back-filling, etc. Sent free by S. R. Dresser Manufacturing Company, Bradford, Pa.

Feeders, Chlorine and Chemical

387. For chlorinating small water supplies, swimming pools and other installations. Flow of water controls dosage of chlorine (or other chemicals) providing required dosages, which are immediately adjustable. Driving is started and stopped automatically. Send for newest literature. %Proportioneers%, 9 Codding St., Providence, R. I.

Fire Hydrants

388. Two new bulletins on M-H fire hydrants and fully bronze mounted gate valves are now ready. Contain full specifications and instructions for ordering, installing, repairing, lengthening and using. Write M. & H. Valve & Fitting Co., Anniston, Ala.

Gate Valves

390. 28 page catalog contains illustrations and complete specifications of M-H standard and extra heavy iron body gate valves, horizontal swing check valves, flanged fittings and flanges, etc. Sent promptly on request by M. & H. Valve & Fittings Co., Anniston, Ala.

Manhole Covers and Inlets

403. Nuisance from loose, noisy manhole covers is eliminated by the use of Westeel rubber cushioned manhole covers and gratings. Six special advantages are explained in a new illustrated bulletin just issued by the West Steel Casting Co., 805 East 70th St., Cleveland, Ohio.

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter, crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

Pipe, Cast Iron

406. Data on cast iron pipe for water works systems, in sizes from 1¼ to 84 inches, including information on useful life, flow data, dimensions, etc., Thos. F. Wolfe, Cast Iron Pipe Research Ass'n, 1013 Peoples Gas Bldg., Chicago, Ill.

Pipe, 2-inch Cast Iron

407. The new McWane 2" cast iron pipe in 18-foot lengths has innumerable uses in water and sewage work. Send for the new McWane bulletin describing this pipe, the various joints used, and other details about it. McWane Cast Iron Pipe Co., Birmingham, Ala.

Pipe, Steel

408a. A very complete, 60 page, illustrated bulletin on spiral welded pipe including lots of useful engineering information, hydraulic data, flow charts, specifications, etc., issued by American Rolling Mill Co., Pipe Sales Div., 1101 Curtis St., Middletown, Ohio.

Pipe Forms

409. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe Joints

410. New folder describes in detail a new type of pipe joint—the Dresser Compression Coupling, Style 65, which is compact and self contained, makes a permanently tight joint under all conditions and is installed on plain end pipe in a few seconds with only one tool, a wrench. Get your copy today. S. R. Dresser Mfg. Co., Bradford, Pa.

Pipe Joint Compound

411. A new bulletin has recently been issued giving full details concerning Tegul Mineralead, a quick-sealing, trouble-free compound for bell and spigot joints which permits immediate closing of the trenches. Write The Atlas Mineral Products Co. of Pa., Mertztown, Pa.

412. New plastic sewer pipe joint compound, Servitite, contains chemicals which positively prevent root growth and gives watertight joint. Get complete information from Servicised Products Corp., 6046 West 65 St., Chicago, Ill.

Taste and Odor Control

413. How, when, and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a new booklet just issued by Industrial Chemical Sales Div., 230 Park Ave., New York, N. Y. 32 pages, table, illustrations and usable data.

Pumps and Well Water Systems

414. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps, fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for these three descriptive booklets. Layne & Bowler, Inc., Dept. W, General Office Memphis, Tenn.

Protective Pipe Coating

415. Coal-tar Pitch Enamels for exterior and interior linings for steel water lines; highly resistant to water absorption, soil acids and alkalis. Technical specifications for materials and their application will be sent on request. The Barrett Company, 40 Rector St., New York, N. Y.

Pumping Engines

417. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Run-off and Stream-Flow

420. Excellent booklet describes and illustrates the latest types of instruments for measuring run-off, both from small areas for storm sewer design, and from large areas for determining water shed yield. Sent promptly by Julien P. Friez & Sons, Baltimore, Md.

Screens, Sewage

421. The simple, automatic Laughlin self-cleaning, traveling screen is fully described in an interesting bulletin issued by Filtration Equipment Co., 10 East 40th St., New York, N. Y.

423. Be asurred of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straight-line Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Avenue, Chicago, Ill.

Setting and Testing Equipment for Water Meters

424. All about setting and testing equipment for Water Meters—a beautifully printed and illustrated 40 page booklet giving full details concerning Ford setting and testing apparatus for all climates. Ford Meter Box Co., Wabash, Ind.

Screens

430. Water Screen Book No. 1252, describes traveling water intake screens and gives complete technical information about them. Link-Belt Co., 307 No. Michigan Ave., Chicago, Ill.

Sludge Bed Glass Covers

432. Sludge Bed Glass Covers—"Super-Frame." Hitchings & Co., Elizabeth, N. J. offer A. I. A. File 101 SB, describing glass covers for sludge and sprinkler beds; details, specifications and cost data.

Sludge Incineration

438. A multiple hearth furnace which meets the most exacting municipal sanitary requirements for the incineration of sewage sludge—produces a fine ash or partially dry sludge for fertilizer—is described and illustrated with drawings and photographs in bulletins issued by Nichols Engineering and Research Corp., 40 Wall St., New York, N. Y. Operation as well as installation data is given.

440. Disposal of Municipal Refuse: Planning a disposal system; specifications. The production of refuse, weights, volume, characteristics. Fuel requirements for incineration. Suggestions for plant inspection, 45 pp., ill. Also detailed outline of factors involved in preparation of plans and specifications. Morse-Boulger Destructor Co., 202P East 44th St., N. Y.

Swimming Pool Equipment

444. Filters, chlorination, underwater lights and other supplies for swimming pools are very thoroughly described in literature and folders. Plans and layouts. Everson Filter Co., 625 W. Lake St., Chicago, Ill.

445. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

Treatment

448. New 31-page catalog covers complete conveying, screening and reduction machinery for water purification and sewage treatment; describes and illustrates the design features of Jeffrey self-cleaning bar screen, combined screen and grinder, sewage screenings grinder, grit washer, conveyor type and positive discharge sludge collectors and green garbage grinder—includes installation views. Catalog 615, Jeffrey Manufacturing Co., Columbus, Ohio.

450. Standard Sewage Siphons for small disposal plants and PFT Rotary Distributors are new catalogs recently issued by Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill. The latter catalog contains typical plans and many illustrations of actual installations.

452. Eliminate sludge bed troubles, forget about weather conditions, odor nuisance, hail insurance and the like. Full details as to how Oliver United Vacuum Filters overcome these problems will be sent to all interested by Oliver United Filters, Inc., 33 West 42nd St., New York, N. Y.

453. How to avoid sludge and scum troubles in settling tanks explained in detail in Book No. 1542—has excellent drawings and photographs, also specifications. Most important are the carefully prepared capacity tables. Link-Belt Co., 307 N. Michigan Ave., Chicago, Illinois.

454. Full information regarding their newest equipment for sewage treatment and water purification will be sent on request by The Dorr Co., 570 Lexington Ave., New York, N. Y.

Thawing Equipment

460. Complete details concerning this quick-acting, efficient, electric pipe thawer which sells for only $39.25 complete, will be sent promptly by Commonwealth Mfg. Corp., Dept. P-710, 3785 Beachmont Ave., Cincinnati, Ohio.

Water Level Recorders, Portable

475. Everyone who has felt the need for a portable ground water level recorder will want this new folder which illustrates and tells all about the accurate, sensitive, Friez Model FW Portable Water Level Recorders. Ideal for ground water studies, hydraulic laboratories, etc. J. P. Friez & Sons, Baltimore & Central Aves., Baltimore, Md.

Water Works Operating Practices

490. This is a reprint of two excellent papers by F. E. Stuart. One outlines a number of filtration and field practices of value. The other presents a lot of kinks the author has picked up in visits to more than 1,000 water works plants. Sent free by Activated Alum Corp., Curtis Bay, Baltimore, Md.

For the Engineer's Library

Brief reviews of the latest books, booklets and catalogs for the public works engineer.

Water and Sewage Chlorination:

Proportioneers, 9 Codding St., Providence, R. I., has issued a book of 8 drawings showing installations of chlorinating equipment for 3 sewage layouts and for 5 waterworks layouts. For sewage, these cover simple gravity flow, chlorination of effluent from pump-metered plant, and chlorination controlled by frequency of dumping of siphon flush tank. For water, chlorination of small variable flow supply using only water line pressure; variable flow with air pressure where water pressure is not available; proportional chlorination of large mains where neither electricity or other facilities, except pipe line pressure is available; feeding controlled from large fire line type of meters; and chlorination of constant rate pumped supplies. Sent on request.

Panorama of Lubrication:

The first three copies of a series giving non-technical information on the manufacture and application of lubricants has been issued by Shell Petroleum Corp., Shell Bldg., St. Louis, Mo. These are excellent in content and appearance. and beautifully illustrated. The extremely interesting presentation of the subject is well worth study. We urge our readers to get these, which will be sent on request to the above.

Pavement Construction and Maintenance:

Barber Co., Inc., Philadelphia, Pa., have issued a booklet on "Trinidasco," a cold laid bituminous product for building, surfacing and maintaining pavements. Well illustrated and prepared. Sent on request to W. F. Hartzell, at the above address.

Belts:

An album of Familiar Belts has been issued by United States Rubber Products, Inc. This contains 25 reproductions of photographs taken in the field and factory and showing interesting and unusual installations. Complete information accompanies each picture.

Water Tanks:

Pittsburgh - Des Moines Steel Co., Neville Island, Pittsburgh, Pa., has issued a new water tank bulletin; 18 pages, illustrations and information regarding water storage in elevated steel tanks. Sent on request to the above.

Electric Arc Welding:

A 24-page catalog on the new 40-volt simplified electric arc welding contains many illustrations of the various jobs this new welder can handle, as well as the complete description of the line, specifications, etc. It will be sent upon request to Hobart Brothers Company, Box FR-173, Troy, Ohio.

Hydraulic Standards:

The seventh edition of its standards for the pump industry has just been published by Hydraulic Institute. The enlarged publication has been completely rewritten and rearranged and much new material has been added, such as a new pump test code, charts for figuring friction of petroleum products in pipe lines, specific pump speed curves, pressure-temperature curves for pumping hot water, and a chart showing resistance of valves and fittings to flow of fluids. Recommendations of materials to be used in pumps handling various liquids, instructions for installing and operating different types of pumps, and much other material has been revised and brought up to date. Price of the book is $1.00 and copies may be had by addressing the secretary, C. H. Rohrbach, 90 West Street, New York.

pH Apparatus:

"Apparatus for Hydrogen-Ion Concentration (pH) Measurements in Laboratory and Plant"; Catalog EN-96; Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, Pa. This 32-page catalog describes and lists the latest forms of L&N electrodes, potentiometers, a potentiometer-electrometer and galvanometers for determining the acidity or alkalinity of aqueous solutions for research and analytical purposes in the laboratory and for control purposes in industrial plants, water works, sewage disposal plants, etc. For control purposes, equipment is described for spot tests and for continuous recorded measurement, which, in the case of certain specific applications, leads to continuous recorded measurement with automatic control. Data on applications, advantages, limitations, useful ranges, limits of error, potentials, etc., simplify the selection of electrodes, potentiometers and galvanometers required. As a result, choosing the most suitable equipment for any proposed application is facilitated.

Hose Data:

U. S. Hose Catalog, 1937 contains 48 pages, and illustrations and data easy to read and understand. Among the most important are air, welding, water, agricultural, spray, lawn, steam, fire and mill, forestry, unlined linen, water suction, agricultural suction, oil, rotary, gasoline, solvent and paint spray hose. A section is devoted to hose couplings and fittings. Sent on request U. S. Rubber Co., 1790 Broadway, N. Y.

Safety in the Small Community:

The National Safety Council has issued a 64-page booklet which outlines details of a safety program for smaller communities. The program is described and illustrated in this booklet, which will be sent on request.

INDEX TO ADVERTISEMENTS

Activated Alum Corp. 34
Alvord, Burdick & Howson.... 55
American Hammered Piston ..52-53
Armco Culvert Mfrs. Assn..... 30
Atlas Mineral Products Co..... 32
Austin-Western Road Mach. Co. 5

Barrett Co. ..... Back Cover
Barstow & LeFeber 55
Bartlett Hayward Div. of Koppers Co. 52-53
Black & Veatch 55
Browne, Floyd G..... 55
Bruning Co., Inc., Charles..... 39
Buffalo-Springfield Roller Co... 43
Burns & McDonnell Engr. Co... 55

Caird, James M..... 55
Cast Iron Pipe Research Assn... 63
C., H. & E. Mfg. Co..... 49
Chevrolet Motor Div..... 4
Cramer & Sons, Robert..... 55

De Witt Hotels 47
Dorr Company, The 6
Dow, A. W., Inc. 55

Etnyre & Co., E. D. 41
Everett, Chester M..... 55
Everson Manufacturing Co..... 38

Ford Meter Box Co..... 36
Friez & Sons, Inc., Julien P..... 32
Frink, Mfr., Carl H..... 49
Fuller & McClintock..... 55

Galion Iron Works & Mfg. Co.. 51
Greeley & Hansen..... 55
Green Co., Howard R..... 55
Gruendler Crusher & Pulverizer Co. 38

Harrub Engineering Co..... 55
Hiler Engr. & Constr. Co., Inc. 52-53
Hill Associates, Nicholas S..... 55

Industrial Chemical Sales Div. 8

Jaeger Machine Co..... 43

Koehring Co. 41
Koppers Coal Co., The.....52-53
Koppers Company 52-53

Layne & Bowler, Inc. 36
Le Tourneau, Inc., R. C..... 42
Link-Belt Co. 54
Littleford Bros. 49
Lock Joint Pipe Co. 32

Mall Tool Co. 49
Maryland Drydock Co., The.. 52-53
McWane Cast Iron Pipe Co..... 35
M & H Valve & Fittings Co..... 34
Metcalf & Eddy..... 55
Mohawk Asphalt Heater Co. ... 46
Morse Boulger Destructor Co... 38
Munsell Concrete Vibrators.... 46

National Paving Brick Ass'n.... 30

Pacific Flush Tank Co..... 38
Pirnie, Malcolm 56
Potter, Alexander 56
Proportioners, Inc. 36
Public Works Magazine 3

Quinn Wire & Iron Works..... 47

Roberts Filter Mfg. Co. 32
Roots-Connersville Blower Corp. 47
Russell & Axton Cons. Engrs., Inc. 56

South Bend Foundry Co..... 47
Standard Oil of N. Y. Div..... 2
Sterling Engine Co..... 56

Tar & Chemical Div. of Koppers Co. 52-53

West Steel Casting Co..... 49
Western Gas Divison of Koppers Co. 52-53
Whitman & Howard 56
White Tar Co. of N. J., Inc., The 52-53
Wiedeman & Singleton..... 56
Wilson Engr. Co..... 56
Wood Preserving Corp., The.. 52-53